SECTION 6

PART B

ENGINE SJ 327 E

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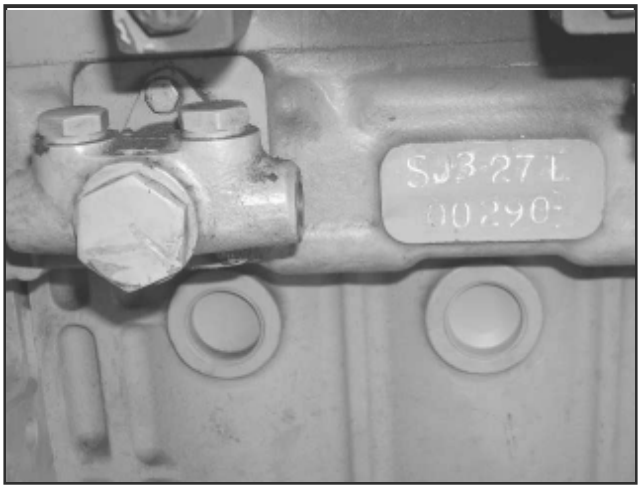
ENGINE NUMBER LOCATION

The engine number is stamped on the camshaft tunnel of the cylinder block (Right side of the engine)

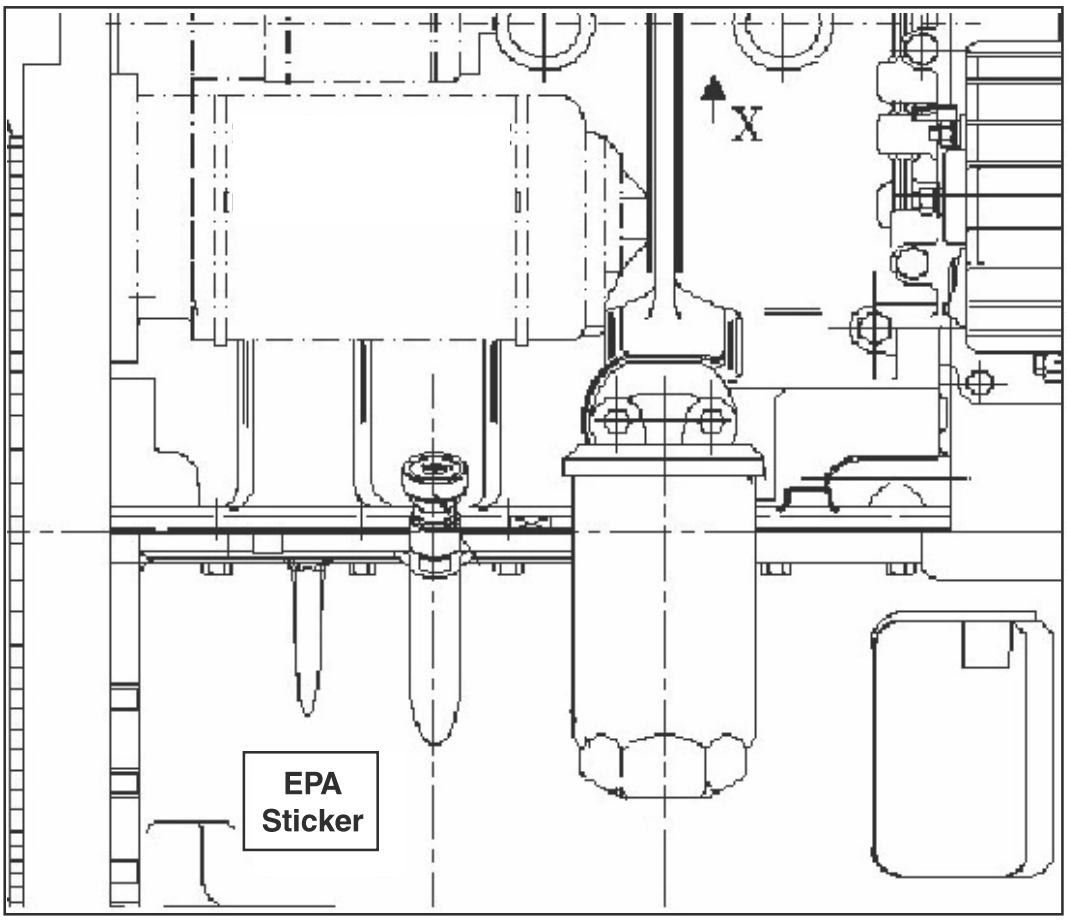


Engine Name Plate Location

When requesting information regarding the engine. the number should be quoted.

ENVIROMENTAL PROTECTION AGENCY (EPA) LOCATION

The EPA Sticker is located on both sides of the engine oil sump



SIMPSONS 'SJ' SERIES DIESEL ENGINES

ALL THREADS USED ON SJ 327 E ENGINE ARE

METRIC SERIES

Except for the components indicated below :

1.	Bolt and Nut. Connecting Rod	...	...	...	7/16" –	20 UNF
2.	Setscrew. Balance Weight	...	...	...	7/16" –	20 UNF
3.	Thermostart fixing hole in the induction manifold		...	...	7/8" –	14 UNF
4.	De-aerator plug on water outlet body	...	...	...	1/4" –	18 NPSI
5.	Coolant temperature sender on coolant outlet body (RHS)		...	...	3/8" –	18 NPSI
6.	Lub oil pressure gauge tapping on cylinder block (LHS)		...	...	1/8" –	27 NPSI

Section B

TECHNICAL DATA

MANUFACTURING DATA AND DIMENSIONS

TECHNICAL DATA

SJ 327 E

Engine Type	:	3 Cylinder. 4 Stroke. Inline Type. Coolant Cooled
Aspiration	:	Naturally Aspirated
Combustion	:	Direct Injection
Bore (Nominal dia.)	:	3.74 inch (95.0 mm)
Stroke	:	5.00 inch (127 mm)
Cubic Capacity	:	0.713 gal (2.7 Lts.)
Compression ratio	:	18.3 : 1
Rotation	:	Anti-clock wise from the flywheel end
Firing order	:	1, 2 , 3
Valve Tip Clearance	:	0.012 inch (0.30 mm) inlet and exhaust
Atomiser setting pressure	:	250 + 8 bar (6 Spray Nozzle)
Inlet valve opens	:	26.8° B.T.D.C.*
Exhaust valve closes	:	25.3° A.T.D.C.**
Total inlet open period	:	250.6°
Total exhaust open period	:	266.6°
Fuel Injection Pump	:	MICO VE type fuel injection pump. mechanical governor
Injection timing	:	0.0314 inch (0.8 mm) plunger lift when No.1 piston at TDC
Fuel feed pump	:	Plunger type pump located on cam tunnel. driven by engine camshaft
Application	:	Tractor

RATING :

Maximum Gross Rating PS (Kw) *	:	49.6 (36.5) @ 2250 rpm
Maximum Gross Torque NM (Kgm)	:	180 (18.35) @ 1200 – 1400 rpm
Rating Standard	:	ISO 14396

*** 1 Kw = 1.341 hp = 1.359 PS (or) CV**

DE-RATING FOR ALTITUDE :

Where engines are called upon to operate in very high atmospheres occasioned by altitude. such engines should be derated.

APPROXIMATE ENGINE WEIGHTS :

Basic weight (with alternator but without starter motor. flywheel & flywheel housing) :449.7 lb (204 Kg).

Typical installed weight (with starter motor. flywheel & flywheel housing) :639.3 lb (290 Kg).

ENGINE DIMENSION :

Height : 30.31 inch (770 mm). Length : 28.75 inch (730 mm). Width : 19.68 inch (500 mm).

* B.T.D.C. – Before Top Dead Center ** A.T.D.C. – After Top Dead Center

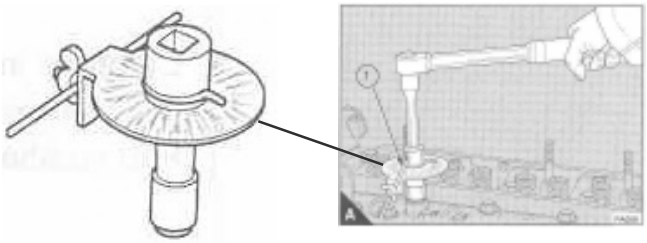
RECOMMENDED TIGHTENING TORQUES

	Nm	lbf.ft	Thread Size
Cylinder head setscrew **(Camshaft tunnel side)**	65	48	(M10 x 1.0)
Cylinder head setscrew	✡	✡	(M12 x 1.5)
Connecting rod nuts (Phosphated)	80	59	(7/16" - 20 UNF)
Main bearing setscrews	155	114	(M14 x 2)
Balance weight setscrews	75	55	(7/16" - 20 UNF)
Idler gear hub nut (lower and upper)	28	21	(M10 x 1.25)
Camshaft gear retaining setscrews	75	55	(M12 x 1.75)
F.I. pump adaptor to F.I. pump camshaft nut	45	33	(M12)
F.I. pump gear to adaptor setscrew	21	15	(M8 x 1.25)
Flywheel setscrews	110	81	(M12 x 1.25)
Crankshaft pulley retaining setscrews	150	111	(M22 x 2.5)
Thermostart	13.6	10	(7/8" - 14 UNF)
High pressure fuel pipe nuts	20	15	–
Atomiser *(Tighten using tubular spanner – Ref. Section E)*	60	44	(M24 x 1.5)

✡ Tighten the cylinder head setscrew in stages according to torque and in the order as shown below

Cylinder Head Tightening Procedure :

1. (a) Place non-asbestos type head gasket on locating dowels with “top mark” on gasket towards cylinder head. This “Non-retorque type” gasket should be fitted dry.
   (b) Ensure the cylinder head is located properly on dowel
   (c) Gradually and evenly tighten the setscrews to 33 lbf.ft.(45 Nm) in first turn using torque wrench
2. In second and third turn use angle torque as shown below :
   (a) Procedure for angle torque using special tool as shown in figure :



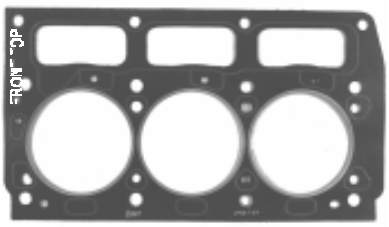
Special Tool used for angular torque

Fit the tool between the socket and the handle. Position the stop (Fig. A1) against a suitable protrusion on the cylinder head to prevent movement of the degree dial in a clockwise direction. Rotate the pointer to align with the relevent angle on the degree dial. Tighten the setscrew until the pointer on the tool is aligned with the zero position on the degree dial.

(b) Procedure for angle forque if no special tool is available :

Make a suitable mark on the cylinder head in line with a corner of each setscrew as shown in the following figure. Make another mark. at the correct angle (counter-clockwise). on the edge of the flange of each fastener. Tighten each setscrew in the correct sequence until the marks on the flange are next to. and in line with. the marks on the cylinder head.

Head Gasket

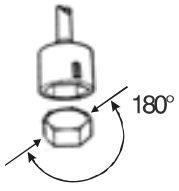


1st Turn 33 lbf.ft (45 Nm)

2nd Turn 180° in one movement

3rd Turn 180° in one movement

Tightening Procedure without special tool



MANUFACTURING DATA AND DIMENSIONS

The following data of clearances and tolerances are given as a guide for personnel engaged in major overhauls and the figures are those used in the factory for production purposes.

Cylinder Block

Height of cylinder block (Top to bottom faces)	...	13.743 / 13.740 inch (349. 085 / 349. 009 mm)
Parent bore dia. for Cylinder Liner	...	3.8583 / 3.8580 inch (98.022 / 98.000 mm)
Depth of Recess for Liner Flange (C.I. Liners)	...	0.157 / 0.155 inch (3.99/3.94 mm)
Dia Recess of Liner Flange (C.I. Liners)	...	4.0476 / 4.0437 inch (102.81/102.71 mm)
Main bearing parent bore	...	2.9175 / 2.9164 inch (74.105 / 74.079 mm)
No. 1 Bore for Camshaft	...	1.875 / 1.874 inch (47.625 / 47.600 mm)
No. 2 Bore for Camshaft	...	1.865 / 1.864 inch (47.375 / 47.350 mm)
No. 3 Bore for Camshaft	...	1.855 / 1.854 inch (47.125 / 47.100 mm)
No. 4 Bore for Camshaft	...	1.845 / 1.844 inch (46.865 / 46.840 mm)

Cylinder Liners – Cast Iron

Type - production liner	...	Dry semi finished – Interference fit.
- Service liner	...	Dry pre finished transition fit
Outside diameter of liner	...	3.861 / 3.860 inch (98.075 / 98.047 mm)
Interference fit of liner in Cylinder Block	...	0.003 / 0.001 inch (0.075 / 0.025 mm)
Inside dia. of finished liner in Cylinder Block	...	3.741 / 3.740 inch (95.022 / 95.000 mm)
Outside dia. of liner flange	...	4.040 / 4.037 inch (102.64 / 102.54 mm)
Flange thickness	...	0.158 / 0.157 inch (4.02 / 4.00 mm)
Liner protrusion above cylinder block machined surface	...	0.003 / 0.0011 inch (0.080 / 0.030 mm) (Above top face of block)

NOTE : *Reboring to oversize is not recommended*

Pistons :

Type	...	Alfin Piston with re-entrant bowl and valve pockets on crown. Offset of combustion bowl in piston crown should be to the FI Pump side while assembling piston in engine. (Offset of valve pockets towards camshaft side)
Piston Height above cylinder block top face	...	0.0059 / 0.0035 inch (0.150 / 0.090 mm) (Above block surface)
Bore Dia. for Gudgeon Pin	...	1.2503 / 1.2501 inch (31.758 / 31.753) mm
Top ring Groove Width	...	0.118 inch (3.0 mm) (Nominal width) – Half Keystone ring
2nd ring Groove Width	...	0.080 / 0.079 inch (2.05 / 2.03 mm)
3rd ring Groove Width	...	0.159 / 0.158 inch (4.05/4.03 mm)

Piston Rings

Top Compression	...	Chromium inlaid. Half Keystone (Symetric barrel on periphery)
2nd Compression	...	Cast Iron. Taper land
3rd Oil Control	...	Conformable oil control ring

NOTE : *Conformable oil control ring fitment procedure*

a. Fit the helical coil spring on to the 3rd groove in the piston
b. Insert the latch into the coil spring aligning both the ends.
c. Fit the outer C.I. ring over the coil spring. Ensure coil spring gets seated properly inside the ring groove.
d. Also ensure the coil spring latch is on the opposite side of the ring open end gap.

Piston Ring Width

Top ring width	...	0.118 inch (3.0 mm) (Nominal)
2nd ring width	...	0.078 / 0.077 inch (1.99 / 1.97 mm)
3rd ring width	...	0.157 / 0.156 inch (3.990 / 3.970 mm)

Ring clearance in Piston Groove :

Top ring clearance in Groove	...	Nil (since keystone)
2nd and 3rd ring clearance in Groove	...	0.003 / 0.0015 inch (0.080 / 0.040 mm)

Ring Gaps

The ring gaps quoted below are for specified bore diameter. When checking ring gaps in a worn bore. 0.0031 inch (0.08 mm) should be added to these ring gaps for every 0.011 inch (0.03 mm) increase in bore diameter

Ring Gap – Top	...	0.0216 / 0.0011 inch (0.55 / 0.30 mm)
Ring Gap – 2nd	...	0.0393 / 0.0314 inch (1.00 / 0.80 mm)
Ring Gap – 3rd	...	0.0216 / 0.0011 inch (0.55 / 0.30 mm)

NOTE : *The ring gaps given above are for when checking in the unworn portion of the cylinder bore.*

Gudgeon Pin

Type	...	Fully Floating
Outside dia. of gudgeon pin	...	1.2497 / 1.2500 inch (31.744/31.750 mm)
Fit in piston boss	...	Transition
Clearance fit in Small end Bush	...	0.0005 / 0.0017 inch (0.0127 / 0.0441 mm)

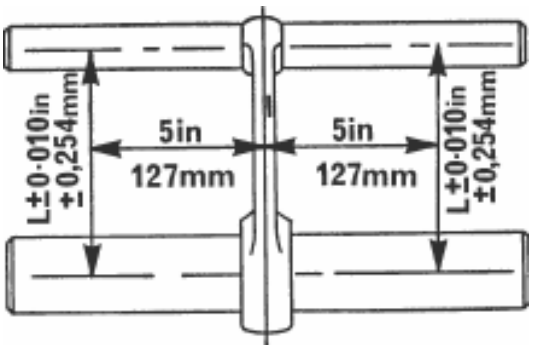
Small End Bush

Type	...	Steel Backed. Lead Bronze Lined
Outside Dia	...	1.3785 / 1.3800 inch (35.0139 / 35.052 mm)
Length	...	1.057 / 1.0381 inch (26.87 / 26.37 mm)
Inside Dia after reaming	...	1.2505 / 1.2515 inch (31.7627/31.7881 mm)

Connecting Rod

Type	...	"H" Section
Big end Parent Bore Dia	...	2.3948 / 2.3956 inch (60.83 / 60.85 mm)
Small end Parent Bore Dia	...	1.3748 / 1.3763 inch (34.92 / 34.96 mm)
Big end Width	...	1.5503 / 1.5523 inch (39.38 / 39.43 mm)
Big end side clearance on Crankpin	...	0.009 / 0.147 inch (0.236 / 0.375 mm)
Length between bore centers	...	8.8129 / 8.8118 inch (223.85 / 223.82 mm)

NOTE : *The numbered side of connecting rod and cap should be on the fuel injection pump side.*



Large and small end bores must be square and parallel to each other within the limits of ± 0.0098 inch (0.25 mm). measured 5.0 inch (127 mm) each side of the axis of the rod on test mandrel as shown in figure. With the small end bush fitted. the limit of ± 0.0098 inch (0.25 mm) is reduced to ± 0.0023 inch (0.06 mm). **Note** : *Connecting rod nuts should be replaced whenever the big ends are disturbed.*

Fig. B1 Connecting Rod Alignment

Connecting Rod Bearings

Type	…	Pre-finished. Steel Backed Aluminium Tin (**or**) Copper lead
Inside Dia.	…	2.250 / 2.252 inch (57.19 / 57.21 mm)
Bearing Running Clearance	…	0.0023 / 0.0039 inch (0.06 / 0.10 mm)
Recommended sizes in service	…	0.0098 inch (0.25 mm) ;0.020 inch (0.51 mm) ;0.0299 inch (0.76 mm)

Crankshaft – (Ref. figure H2)

A – Main Journal Dia. (Std.)	…	2.748 / 2.479 inch (69.81 / 69.83 mm)
B – Crank pin Dia. (Std.)	…	2.248 / 2.249 inch (57.11 / 57.13 mm)
C – Main Journal length Nos. 2 and 3	…	2.2145 / 1.2228 inch (30.85 / 31.06 mm)
D – Crankpin length	…	1.5168 / 1.57 inch (39.67 / 39.88 mm)
E – Main Journal Length-Rear	…	1.8425 / 1.8456 inch (46.80 / 46.88 mm)
R1 – Main Journal fillet radii Nos. 1. 2 and 3	…	0.1248 / 0.14 inch (3.170 / 3.556 mm)
R2 – Crankpin fillet radii	…	0.172 / 0.1559 inch (4.37 / 3.96 mm)
R3 – Main Journal fillet radious No. 4 (Last)	…	0.1562 / 0.1661 inch (3.97 / 4.22 mm)
Surface finish (all Pins and Journals)	…	0.4 microns (Maximum)
Crankshaft end Float	…	0.00196 / 0.0149 inch (0.05 / 0.38 mm)
Crankshaft rear end Seal	…	Cassette type
Regrind Undersizes. Main and Pins	…	0.0098 inch (0.25 mm) ;0.020 inch (0.51 mm) ;0.0299 inch (0.76 mm)

NOTE : *When regrinding. the crank pin length should not exceed 1.5748 inch (40.00 mm) and the rear main journal (Crankshaft with lip type rear oil seal) length should not exceed 1.8610 inch (47.27 mm) and Nos. 2 and 3 main Journals width should not exceed 1.2275 inch (31.1785 mm) maximum.* ***The maximum permissible undersize is 0.0299 inch (0.76 mm)***

Crankshaft Thrust Washers

Type	…	Steel Backed. Aluminium Tin (or)Copper Lead
Position in engine	…	Cylinder Block Rear Main Bearing Housing
Thickness-Standard Size	…	0.1208 / 0.1228 inch (3.07 / 3.12 mm)
Thickness-Oversize	…	0.1283 / 0.1303 inch (3.26 / 3.31 mm)

NOTE : *While locating the Thrust Washers. ensure that the plain surface/Steel back is towards the block and the rear main bearing cap.*

Main Bearings

Type	...	Pre-finished. Steel Backed. Aluminium Tin/Copper Lead
Inside Dia. (fitted)	...	2.7519 / 2.7535 inch (69.90 / 69.94 mm)
Running clearance	...	0.0027 / 0.0051 inch (0.07 / 0.13 mm)
Recommended size in service	...	0.0098 inch (0.25 mm) ;0.020 inch (0.51 mm) ;0.0299 inch (0.76 mm)

Camshaft

Type	...	Polydine *(Hollow shaft. Journals are pressure feed lubrication. located with thrust washer)*
No. 1 Journal Dia.	...	1.8700 / 1.8694 inch (47.5 / 47.484 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
No. 2 Journal Dia.	...	1.8602 / 1.8596 inch (47.25 / 47.234 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
No. 3 Journal Dia	...	1.8503 / 1.8497 inch (47.00 / 46.984 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
No. 4 Journal Dia	...	1.8401 / 1.8395 inch (46.74 / 46.724 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
Oil way for rocker shaft lubrication	...	From head to 1st rocker bracket top face
Cam Lift *Inlet*	...	0.2512 inch (6.3814 mm)
Exhaust	...	0.292 inch (7.4169 mm)
Gear–Spigot dia	...	1.3779 / 1.3769 inch (35.000 / 34.975 mm)
Camshaft end float	...	0.0157 / 0.039 inch (0.40 / 0.10 mm)

Cylinder Head

Cylinder head total height	...	4.645 inch (118 mm)
Skimming allowance on head face	...	A maximum of 0.0118 inch (0.30 mm) may be removed from the Head Face provided the atomiser nozzle protrusion does not exceed 0.147 inch (3.75 mm) after skimming
Leak Test	...	4 Bar for 1 minute
Valve seat angle	...	Inlet 30° / Exhaust 45°
Tappet bore in cylinder head	...	0.6306 / 0.6299 inch (16.018 / 16.000 mm)
Valve guide bore in cylinder head	...	0.5125 / 0.5118 inch (13.018 / 13.000 mm)
Permissable cylinder head bow transverse and longitudinal	...	0.00314 inch (0.080 mm)

Valve Guides (Sintered) – Inlet and Exhaust

Inside Dia.	...	0.3110 / 0.3116 inch (7.900 / 7.915 mm)
Outside Dia	...	0.5127 / 0.5131 inch (13.023 / 13.034 mm)
Overall Length	...	2.3228 / 2.3149 inch (59.00 / 58.8 mm)
Guide Protrusion above Cyl. head Top Face	...	0.3917 / 0.3956 inch (9.95 / 10.05 mm)
Interference fit of guide in head	...	0.0013 / 0.00019 inch (0.034 / 0.005 mm)

NOTE : *Valve stem seal (with Sintered metal insert) is fitted in both inlet and exhaust valves.*

Inlet and Exhaust Valves

Valve Stem Dia *(Inlet)*	...	0.3101 / 0.3095 inch (7.877 / 7.863 mm)
Valve Stem Dia. *(Exhaust)*	...	0.3096 / 0.3090 inch (7.864 / 7.850 mm)
Clearance fit of valve in guide *(Inlet)*	...	0.00091 / 0.0025 inch (0.023 / 0.052 mm)
Clearance fit of valve in guide *(Exhaust)*	...	0.0014 / 0.0025 inch (0.036 / 0.065 mm)
Valve face Angle *(Inlet)*	...	29° 40'
Valve face Angle *(Exhaust)*	...	44° 40'
Valve depth below cylinder head face	...	0.0079 inch (0.203 mm) above or below *(Inlet and Exhaust)* cylinder head machined surface

Valve Seat Insert (Sintered)

Outer Dia.	Inlet	...	1.6602 / 1.6596 inch (42.170 / 42.154 mm)
	Exhaust	...	1.5254 / 1.5218 inch (38.670 / 38.654 mm)
Thickness	Inlet	...	0.242 / 0.2381 inch (6.15 / 6.05 mm)
	Exhaust	...	0.257 / 0.2530 inch (6.55 / 6.45 mm)

Valve Spring

Free length	...	1.771 inch (45.0 mm)
Fitted length	...	1.496 inch (38.0 mm)
Load at fitted length	...	111 lbf.ft (150 Nm)

Tappet

Outside Dia. of Shank	...	0.6292 / 0.6288 inch (15.984 / 15.973 mm)
Clearance fit in Cylinder head	...	0.0062 / 0.0017 inch (0.0160 / 0.0450 mm)

Rocker Shaft

Outside Diameter	...	0.748 / 0.747 inch (19.000 / 18.979 mm)

Rocker Lever

Bush Bore Diameter	...	0.7484 / 0.7504 inch (19.010 / 19.061 mm)
Running clearance of Bush on Shaft	...	0.00039 / 0.0032 inch (0.010 / 0.082 mm)

Timing Gears

Crankshaft gear – Steel	...	26 Teeth
Idler gear (Lower) – Steel	...	48 Teeth
Idler gear (Upper) – Steel	...	43 Teeth
Camshaft gear – C I	...	52 Teeth
Fuel Pump gear – Steel	...	52 Teeth

Camshaft Gear

Gear Bore Diameter	...	1.3789 / 1.3779 inch (35.025 / 35.00 mm)
Clearance fit of Gear on Spigot	...	0.000 / 0.0019 inch (0.00 / 0.05 mm)

Idler Gear and Hub (Upper / Lower) – *Gear Without Bush*

Bore Dia of gear	...	2.0007 / 1.9998 inch (50.818 / 50.795 mm)
Diameter of hub	...	1.9968 / 1.9956 inch (50.72 / 50.69 mm)
Clearance of gear on hub	...	0.0050 / 0.0029 inch (0.128 / 0.075 mm)
Gear Width	...	1.1935 / 1.1905 inch (30.315 / 30.239 mm)
Bearing length of hub	...	1.6019 / 1.5940 inch (40.69 / 40.49 mm)
Gear end-float	...	0.0079 / 0.0030 inch (0.203 / 0.077 mm)

Lower Idler Gear. Bush and Hub - *(Gear With Bush)* ... *Optional for Front P.T.O. application only*

Idler Gear Hub Diameter	...	1.9960 / 1.9968 inch (50.70 / 50.72 mm)
Gear Bush Bore Diameter	...	1.9996 / 2.0007 inch (50.79 / 50.82 mm)
Clearance between Hub and Bush	...	0.0027 / 0.0047 inch (0.07 / 0.12 mm)
Hub Width	...	1.1905 / 1.1933 inch (30.24 / 30.31 mm)
Width of Gear with Bushes	...	1.1866 / 1.1874 inch (30.14 / 30.16 mm)
Idler Gear end Float	...	0.0079 / 0.0030 inch (0.203 / 0.077 mm)

NOTE :*The bore and faces of bushes should be finished to the specified dimensions by machining after pressing the bushes in the gear bore.*

Crankshaft Gear

Diameter of Bore	...	1.4996 / 1.5011 inch (38.090 / 38.13 mm)
Spigot Dia of crankshaft	...	1.5005 / 1.5000 inch (38.113 / 38.10 mm)
Transition fit of Gear on Crankshaft	...	0.011 / 0.0015 inch (0.03 / 0.04 mm)

Fuel Pump Gear *(Without timer)*

Diameter of Bore	...	1.8911 / 1.8916 inch (48.035 / 48.056 mm)
Pump adaptor Dia.	...	1.8897 / 1.8887 inch (48.000 / 47.975 mm)
Clearance fit of gear on spigot	...	0.0039 / 0.0022 inch (0.100 / 0.056 mm)

Timing Gear Backlash

All Gears	...	0.0031 inch (0.08 mm) (min.)

Lubricating Oil Pump

Oil Pump type	...	Rotor
Number of teeth on drive gear	...	19
Number of teeth on idler gear	...	15
Backlash between idler and drive gear	...	0.0031 / 0.0149 inch (0.080 / 0.380 mm)
Backlash between idler and C/S gear	...	0.01 / 0.0125 inch (0.254 / 0.320 mm)

Lubricating Oil Pump Drive Gear

Internal Dia. of Gear Bore	...	0.4960 / 0.4972 inch (12.60 / 12.63 mm)
Pump drive shaft Dia.	...	0.4988 / 0.4996 inch (12.67 / 12.69 mm)
Interference fit of Gear on Shaft	...	0.0019 / 0.0031 inch (0.05 / 0.08 mm)

Lubricating Oil Pump Idler Gear

Inside Dia. of Gear Bore	...	0.7500 / 0.7511 inch (19.05 / 19.08 mm)
Outside Dia. of Bush	...	0.7519 / 0.7535 inch (19.10 / 19.14 mm)
Interference fit of Bush in Gear	...	0.0011 / 0.0035 inch (0.03 / 0.09 mm)
Inside Dia. of Bush Fitted	...	0.6562 / 0.6570 inch (16.67 / 16.69 mm)
Dia. of Gear Shaft	...	0.6547 / 0.6551 inch (16.63 / 16.64 mm)
Running clearance of Gear on Shaft	...	0.0007 / 0.0025 inch (0.02 / 0.064 mm)
Gear end Float	...	0.0007 / 0.0228 inch (0.20 / 0.58 mm)

Lubricating Oil Pump Clearances

Inner Rotor to Outer Rotor	...	0.00039 / 0.0023 inch (0.01 / 0.06 mm)
Inner Rotor end clearance	...	0.0015 / 0.0031 inch (0.04 / 0.08 mm)
Outer Rotor end clearance	...	0.00039 / 0.0023 inch (0.01 / 0.06 mm)
Outer Rotor to Pump Body	...	0.0110 / 0.01299 inch (0.28 / 0.33 mm)

Lubricating System Pressure

Lubricating Oil Pressure	...	29.869 / 59.738 psi (2.1 / 4.2 kg per cm^2) at maximum engine speed and normal working temperature

Lubricating Oil Relief Valve

Type	...	Spring loaded plunger type valve
Pressure Setting	...	50.0662 / 65 psi (3.52 / 4.57 kg per cm^2)

Lubricating Oil Filter

Type	...	Full Flow
Element	...	Replaceable Paper / Canister
By-pass Valve Setting	...	12.94 / 17.06 psi (0.91 / 1.20 kg per cm^2)

Sump Capacity ... 1.585 gal (6 lts). Sump capacity vary according to application

Cooling System

Type	...	Thermosyphon-Pump assisted
Coolant capacity–Engine only	...	1.320gal (5 lts). (approximate)

Thermostat

Type	...	Wax
Opening temperature	...	167 ± 35.6°F (75° ± 2°C)
Fully open	...	192.2 ± 35.6°F (89° ± 2°C)

Water Pump

Type	...	Centrifugal
Outside Dia. of Shaft for Pulley	...	0.6263 / 0.6267 inch (15.91 / 15.92 mm)
Inside Dia. of Pulley Bore	...	0.6240 / 0.6248 inch (15.85 / 15.87 mm)
Interference fit of Pulley on Shaft	...	0.0015 / 0.0027 inch (0.04 / 0.07 mm)
Inside Dia. of Impeller Bore	...	0.6251 / 0.6255 inch (15.88 / 15.89 mm)
Ouside dia of shaft for impeller	...	0.6263 / 0.6267 inch (15.91 / 15.92 mm)
Interference fit of Impeller on Shaft	...	0.00039 / 0.0015 inch (0.01 / 0.04 mm)
Impeller to Body Clearance	...	0.00984 / 0.0200 inch (0.25 / 0.51 mm)
Distance between impeller rear face to the water pump pulley front machined face on the large Dia.	...	5.5314 ± 0.1496 inch (140.5 ± 0.38 mm)

Fuel System

Fuel oil specification	...	Fuel oil should conform to IS : 1460 / 2000 grade-special or grade-A specification.
Fuel Filter Type	...	MICO dual filter 0.132 gal (0.5 litre) capacity. spin on type (primary and secondary)
Fuel Overflow Valve Type	...	MICO spring loaded valve
Overflow Valve Location	...	Fuel Injection Pump
Fuel Feed Pump	...	Plunger type pump located on cam tunnel. driven by engine camshaft

Fuel Injection Pump

Make	...	MICO. India
Type	...	VE type
Mounting	...	Flange mounted
Drive	...	Gear
Pump Rotation	...	Anti-clockwise
Governor	...	VE type mechanical governor
Fuel injection timing	...	*Refer Sec. B / Sec.K*

Alternator

Make	...	**Lucas-TVS. India**
Volts	...	12 V
Max. Output	...	36 Amps

Starter Motor

Make	...	**Lucas-TVS. India**
Type	...	3SM114. 12 V Solenoid operated
No. of teeth on pinion	...	10
Starter Cable Resistance	...	0.0017 ohms maximum
Rotation	...	Normaly clockwise

Note : *The above electrical data is general and can vary with individual application*

Cold starting Aid (Standard fitment)

Device	...	Thermostart
Voltage	...	12 volts
Location	...	Induction manifold

Section C

OPERATING AND MAINTENANCE

OPERATING AND MAINTENANCE

Preparation for Starting

Check the radiator coolant level.

Check the engine sump oil level.

See that there is fuel oil in the tank

Check that the starter battery is fully charged and that all electrical connections are properly made and all circuits in order.

Starting the Engine

If the engine is warm. turn starter switch in a clockwise direction to the "Heat and Start" position (Ref. Fig. C.1.)

As soon as the engine starts. release the switch to the "ON" position.

Be sure that the starter pinion and engine have stopped rotating before re-engaging the starter motor. Otherwise damage may result.

If weather is cold. turn starter switch to the "Heat" position (Ref. Fig. C.1) and hold it there for fifteen to twenty seconds. (For – 59°F or 15°C) operation. hold it for 40 – 45 seconds)

Then turn the starter switch to the "Heat and Start" position. thereby engaging the starter motor.

If the engine does not start after twenty seconds. return the switch to the "Heat" position for ten seconds and then re-engage the starter motor by switching to the "Heat and Start" position.

As soon as the engine starts. release the switch to the "ON" position.

Starting the Engine (Alternative Method)

With some engines. a different starter switch may be found and the cold start aid operated by means of a separate push button switch.

The cold starting procedure is however the same. i.e.

Switch on by turning the starter switch in a clockwise direction to the first position

Press the heater button for fifteen to twenty seconds (For – 59°F(15°C) operation. press it for 40 – 45 seconds) and then. with the heater button still pressed. turn the starter switch in a further clockwise direction to engage the starter motor. As soon as the engine starts. release both starter switch and heater button.

Cold Starting Aid

Referring to Fig. C.2 the cold start unit comprises a tubular valve body carried in a holder which screws into the inlet manifold. and surrounded by a heater coil. an extension of which forms an igniter coil. The valve body houses a needle. the stem of which holds a ball valve in position against its seating. The whole is surrounded by an open perforated shield. Fuel oil from the container enters through an adaptor.

When the unit is cold. the ball valve is held closed. On switching on the coil. the valve body is heated and

1. Off Position

2. ON / Accessories

3. Preheat

4. Start Position

Fig. C. 1 Combination Switch

expands. opening the ball valve and permitting the entry of fuel. The fuel is vapourised by the heat of the valve body and when the engine is cranked and air is drawn into the manifold. the vapour is ignited by the coil extension and continues to burn. thus heating the inlet air. (Refer Fig. C3 for cold start layout).

To Stop the Engine

A spring loaded stop control is located near the engine controls and functions by cutting off the fuel at the fuel injection pump.

Turn start switch to the Off position.

Things to Note

Always be sure that the starter pinion has stopped revolving before re-engaging the starter. otherwise the ring or pinion may be damaged.

Ensure that the electrical connection to the cold starting aid is correctly made. (Ref. Fig. C. 3)

Always ensure that. if a reservoir is used to feed fuel to the starting aid. it is fully primed and is not leaking. On later engines. the starting aid fuel feed is taken directly from the fuel tank or fuel filter.

When the coil is switched off. the flow of air in the manifold cools the valve body rapidly and the valve closes.

The cold start aid is a sealed unit and cannot be dismantled. If the unit ceases to function. it must be renewed.

In the event of difficult starting. check that fuel is reaching the cold starting aid in the induction manifold by unscrewing the inlet fuel connection. If fuel is reaching it satisfactorily. then it may be that the cold starting aid itself is not working correctly. This can be checked by removing the air cleaner and watching the cold starting aid whilst the equipment is used. When the starting switch is turned to the “heat” position. the element should become red hot. and on engagement of the starter motor. it should ignite into flames.

SJ327 E engines are fitted with efficient cold starting equipment and no responsibility can be accepted for any damage caused by unauthorised starting aids.

Running-in Procedure

It is not necessary to gradually run-in a new engine and any prolonged light load running during the early life of the engine and in could prove harmful to the run in of piston rings and liners.

Full load can be applied on a new engine as soon as the engine is used. Provided that the engine coolant is first allowed to reach a temperature of at least 140° F (60° C).

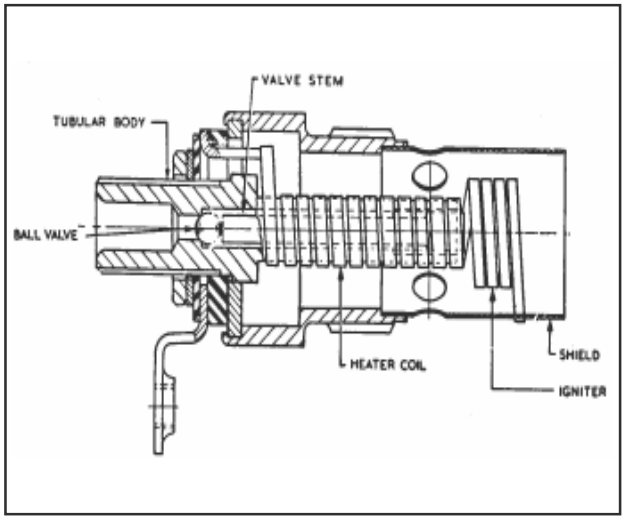


Fig. C 2 – Thermostart

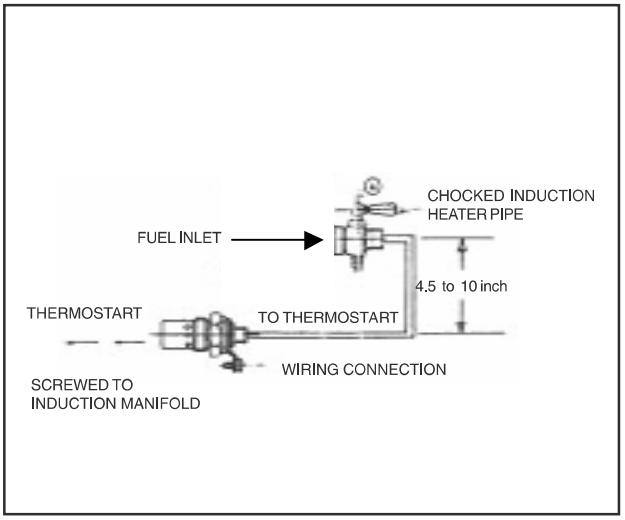


Fig. C 3 – Typical Layout of Cold Start Aid

PREVENTIVE MAINTENANCE

DAILY OR EVERY 8 HOURS WHICHEVER OCCURS FIRST:

Keep Engine Clean.

Check level of coolant.

Check level of oil in sump.

Check oil pressure (where gauge fitted).

EVERY 250 HOURS:

Drain and renew lubricating oil. Refer to list of Approved lubricating Oils in Sec. Q.

Renew lubricating oil filter (canister).

Check drive belt tension.

* Clean and replace paper element (Dry type air cleaner)

Clean fuel lift pump pre-filter (where fitted).

Check engine for leakage of oil and coolant.

EVERY 500 HOURS :

Check hoses and clamps.

Check atomisers.

Examine valve springs and check valve tip clearances.

Inspect valve rocker shaft assembly for lubrication.

Clean and treat battery terminals.

EVERY 1000 HOURS:

Drain fuel tank. remove and clean.

Flush radiator with clean coolant.

NOTE :

(a) The time for cleaning the air cleaner depends on operating conditions; therefore under extremely dusty conditions. the time limit recommended above for cleaning should be decreased.

The correct maintenance of the air cleaner will greatly assist in reducing bore wear. thereby extending the life of the engine.

(b) Dry Type Air Cleaner with Turbo Type Pre Cleaner

- Main Paper Element can be cleaned twice only with pressurized air (applying from inside to outside) before replacement. Remove the Main Paper Element from the assembly for cleaning purpose.
- 1st Cleaning after 100 Hrs.
- 2nd cleaning after 200 Hrs.
- Discard after complete plugging.
- Inner secondary element has been provided to safeguard against dust entry in case of puncturing of Main Element. It is to be replaced with the fitment of third Main Paper Element.
- Remove the dust every 50 Hrs. from dust unloader by press opening the lip.

FUEL FILTERS MAINTENANCE

Do not clean filter canister.

Drain filter bowls after every 125 hrs. of operation by loosening sludge screws (wherever provided). until clean fuel flows out.

DUAL FILTERS

Replace first stage filter (primary) after every 500 hrs. (spin on type).

Replace second stage filter (secondary) after every 750 hrs. (spin on type).

Operators of SJ327 E engines are reminded that the above Preventive Maintenance are general in application: therefore the operator should compare the routine maintenance for their engine with the schedules specified by the manufacturer of the application to which the engine is fitted and where necessary adopt the shorter periods.

While we have given specific periods for preventive maintenance. you should have due regard for the local regulations concerning your machine and ensure that the engine is operating within those regulations.

Post-Delivery Checkover

After a customer has taken delivery of their diesel engine. it is advisable in their own interest that a general checkover of the engine be carried out after the first 25 hours in service.

It is also recommended that the following procedure be

adopted where an engine has been stored for a considerable period before it is again put into service.

The checkover should comprise the following points:-

1. Drain lubricating oil sump and re-fill up to the full mark on the dipstick with new clean oil (Do not overfill).
2. Renew the lubricating oil filter (canister).
3. Check external nuts for tightness.
4. Check and adjust valve tip clearances to 0.012 inch (0.30 mm) to inlet and exhaust valve cold or hot.
5. Check fuel pipes from tank to fuel injection pump for leaks.
6. Check for lubricating oil leaks and rectify if necessary.
7. Check hose clamps for tightness.
8. Check cooling system for leaks and inspect radiator coolant level.
9. Check fan belt for tension.
10. Carry out test to check general performance of engine.
11. Check engine mounting bolts for tightness.

It is assumed that electrical equipment will have already been checked for such points as rate of charge. effectiveness of connections and circuits. etc.

Thereafter maintenance periods should be in accordance with the instructions given.

Preservation of stored Engines

Where an application which is powered by Simpsons engine is to be stored for several months it is advisable that some measure of protection be afforded to the engine to ensure that it suffers no ill effects during the intervening period before operations are recommenced.

It is recommended therefore, that the following procedure be adopted and applied immediately if the unit is removed from service:

1. Thoroughly clean all external parts of the engine.
2. Run the engine until it reaches operating temperature. Stop the engine and drain lubricating oil from sump.
3. Drain coolant from radiator and engine cylinder block.
4. After replacing filters fill the sump to correct level with clean new lubricating oil or with a suitable preservative fluid.
5. Remove atomisers and spray into cylinder bores 150 ml of lubricating oil divided between the cylinders.
6. Turn engine slowly over compression and replace atomisers.
7. Remove air cleaner and any intake pipe which may be fitted between the air cleaner and air intake. Carefully seal air intake orifice with waterproof adhesive tape or some other suitable medium.
8. Remove exhaust pipe and seal opening in manifold as in '7'.
9. Disconnect battery and store in fully charged condition. Before storing the battery. terminals should be treated to prevent corrosion.

The fuel system may either be drained and charged with a suitable preservative designed for the prevailing climatic conditions or alternatively. it may be left primed with normal fuel oil.

Where the latter course is taken it should be noted that deterioration of the fuel oil may occur during the months the fuel system is idle.

If this occurs. the fuel oil may become contaminated with a wax-like substance which will quickly clog the fuel filtering arrangement once the engine is returned to service.

Therefore. before commencing operations in respect of a unit primed with normal fuel oil which has been idle for several months it is recommended that the fuel tank be drained and the interior of the tank thoroughly cleaned. The fuel oil drained off should be discarded as unfit for further use.

Fuel oil contained in the remainder of the fuel system should also be dispelled and the fuel filter renewed. following which the system may then be recharged with fresh clean fuel oil.

Before starting. the engine should be cranked over by the starter motor with the stop control in the 'off' position until oil pressure is recorded or the oil warning light is extinguished. Do not rapidly accelerate the engine after

initial start. allow it to run at slow speed for approximately two minutes to ensure good oil circulation before accelerating to higher speeds.

NOTE: *Where a preservative is used in the lubricating oil sump. this should be drained off and replaced by normal lubricant prior to restarting the engine at the end of the storage period. In the case of a preservative being utilised to charge the fuel system. this need not necessarily be drained off before returning the engine to service. Therefore. where a preservative is used in this respect. the relevant manufacturers of the fluid should be contacted seeking their guidance as to whether their product should be drained away prior to restarting the engine.*

Frost Precautions

Precautions against damage by frost should be taken if the engine is to be left exposed to inclement weather either by adequately draining the coolant system or where this is not convenient an anti-freeze of reputable make and incorporating a suitable corrosion inhibitor may be used.

Should it be the policy to protect engines from frost damage by adding anti-freeze to the cooling system. it is advisable that the manufacturers of the relevant mixture be contacted to ascertain whether their products are suitable for use in Simpsons engines. and also to ensure that their products will have no harmful effect on the cooling system generally. It is our experience that the best results are obtained from anti-freeze which conforms to ***British Standard 3151*** or has been approved by testing in accordance with ***BS 5117. Clause 5.*** to give atleast as good a result as ***BS 3151:1959.***

The coolant solution containing 25 per cent ***anti-freeze manufactured to BS 3151*** in coolant in a properly maintained engine should maintain its anti-freeze and anti-corrosive properties throughout the winter season and in general. a safe life of 12 months may be reasonably expected.

When draining the coolant circulating system it is not enough merely to open the radiator drain tap. The one on the cylinder block must also be opened. This tap is on the rear side of the cylinder block. near the flywheel housing.

Where a pressurised radiator filler cap is fitted. this should be removed before draining the cooling system.

When draining the cooling system ensure that the engine is level.

When the engine cooling coolant is drained. in the majority of applications the water pump is also drained. but rotation of the pump may be prevented by :

(a) Locking of the impeller by ice due to the pump drain hole being blocked by sediment.

(b) The locking of the seal through the freezing of globules of moisture between the seal and the gland.

Operators are therefore advised to take these precautions when operating in temperatures below freezing point:

1. Before starting the engine. turn the fan and water pump by hand: this will indicate if freezing has taken place. If freezing has taken place. this should free any ice formation.

2. If it is impossible to turn the pump by hand. the radiator and engine should be filled with warm water.

After an anti-freeze solution has been used. the cooling system should be thoroughly flushed in accordance with the manufacturer's instructions before refilling with normal coolant.

If the foregoing action is taken. no harmful effects should be experienced. but manufacturer cannot be held responsible for any frost damage or corrosion which may be incurred.

Section D

FAULT FINDING CHART

SECTION D FAULT FINDING CHART

The following table lists problems and their possible causes with recommended action.

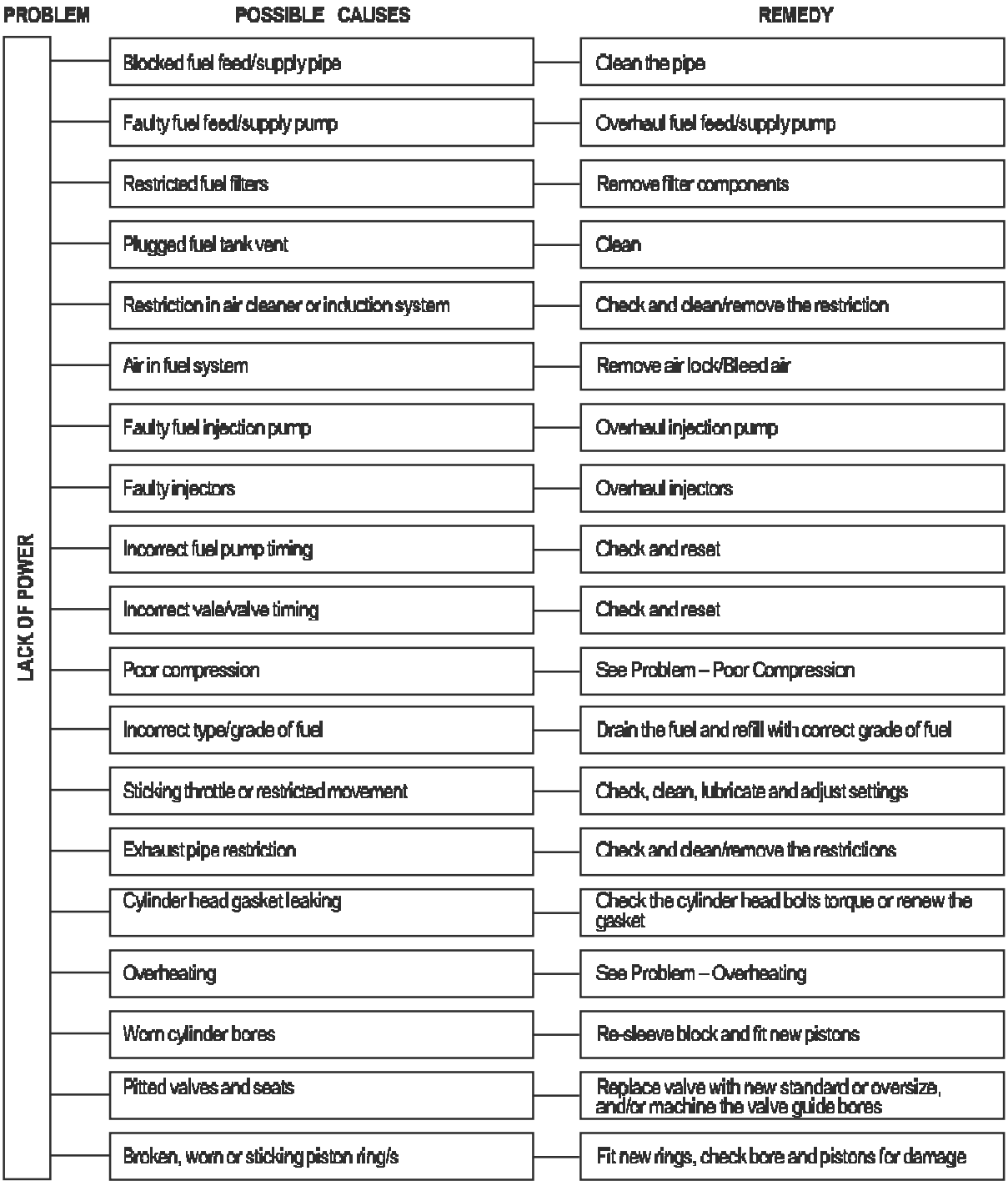
IMPORTANT : *When attending/performing a repair, the cause of the problem must also be investigated and corrected to avoid repeat failures.*

PROBLEM	POSSIBLE CAUSES	REMEDY
LOW CRANKING SPEED	Battery capacity low	Change or renew the battery
	Bad electrical connections	Check the connections or renew electricals
	Faulty starter motor	Overhaul starter motor
	Lubricating Oil of incorrect grade	Drain and refill with specified grade of oil
ENGINE DOES NOT START	Low cranking speed	See Problem – Low Cranking speed
	Fuel tank empty	Fill the tank with fuel
	Incorrect type or grade of fuel	Drain and refill with correct type/grade of fuel
	Faulty stop control operation	Check the stop control cable movement and setting
	Blocked fuel feed/supply pipe	Clean the pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Chocked/Plugged fuel filters	Renew filter elements
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Broken fuel injection pump drive	Fit new drive
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valve/s and seat/s	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new ring/s, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
DIFFICULT STARTING	Low cranking speed	See Problem – Low Cranking Speed
	Faulty stop control operation	Check the stop control cable movement and setting
	Blocked fuel feed/supply pipe	Clean
	Blocked fuel tank vent	Clean
	Incorrect type or grade of fuel	Drain the fuel and refill with correct grade of fuel
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Renew filter elements
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Sticking valves	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
MISFIRING	Restricted fuel feed/supply pipe	Clean pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Remove filter elements
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor compression
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew the pipes of correct specification
	Pitted valves and seats	Replace valve with new standard or oversize, and/or machine the valve guide bores.

PROBLEM	POSSIBLE CAUSES	REMEDY
EXCESSIVE CRANKCASE PRESSURE	Plugged breather pipe	Clean the pipe
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Worn valve stems and guides	Renew valves and guides
	Piston seized inspect the bore for damage	Replace with new pistons assembly and check/
POOR COMPRESSION	Overheating	See Problem – Overheating
	Incorrect valve timing	Reset the timing
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize and / or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and piston for damage
	Worn valve stems and guides	Renew valves and guides
	Broken valve springs	Fit new springs


PROBLEM
POSSIBLE CAUSES
REMEDY
LACK OF POWER
Blocked fuel feed/supply pipe
Clean the pipe
Faulty fuel feed/supply pump
Overhaul fuel feed/supply pump
Restricted fuel filters
Remove filter components
Plugged fuel tank vent
Clean
Restriction in air cleaner or induction system
Check and clean/remove the restriction
Air in fuel system
Remove air lock/Bleed air
Faulty fuel injection pump
Overhaul injection pump
Faulty injectors
Overhaul injectors
Incorrect fuel pump timing
Check and reset
Incorrect vale/valve timing
Check and reset
Poor compression
See Problem – Poor Compression
Incorrect type/grade of fuel
Drain the fuel and refill with correct grade of fuel
Sticking throttle or restricted movement
Check, clean, lubricate and adjust settings
Exhaust pipe restriction
Check and clean/remove the restrictions
Cylinder head gasket leaking
Check the cylinder head bolts torque or renew the gasket
Overheating
See Problem – Overheating
Worn cylinder bores
Re-sleeve block and fit new pistons
Pitted valves and seats
Replace valve with new standard or oversize, and/or machine the valve guide bores
Broken, worn or sticking piston ring/s
Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
EXCESSIVE FUEL CONSUMPTION	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul Injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor compression
	Incorrect type or grade of fuel	Drain the fuel and refill with correct grade of fuel
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize and/or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize and/or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage

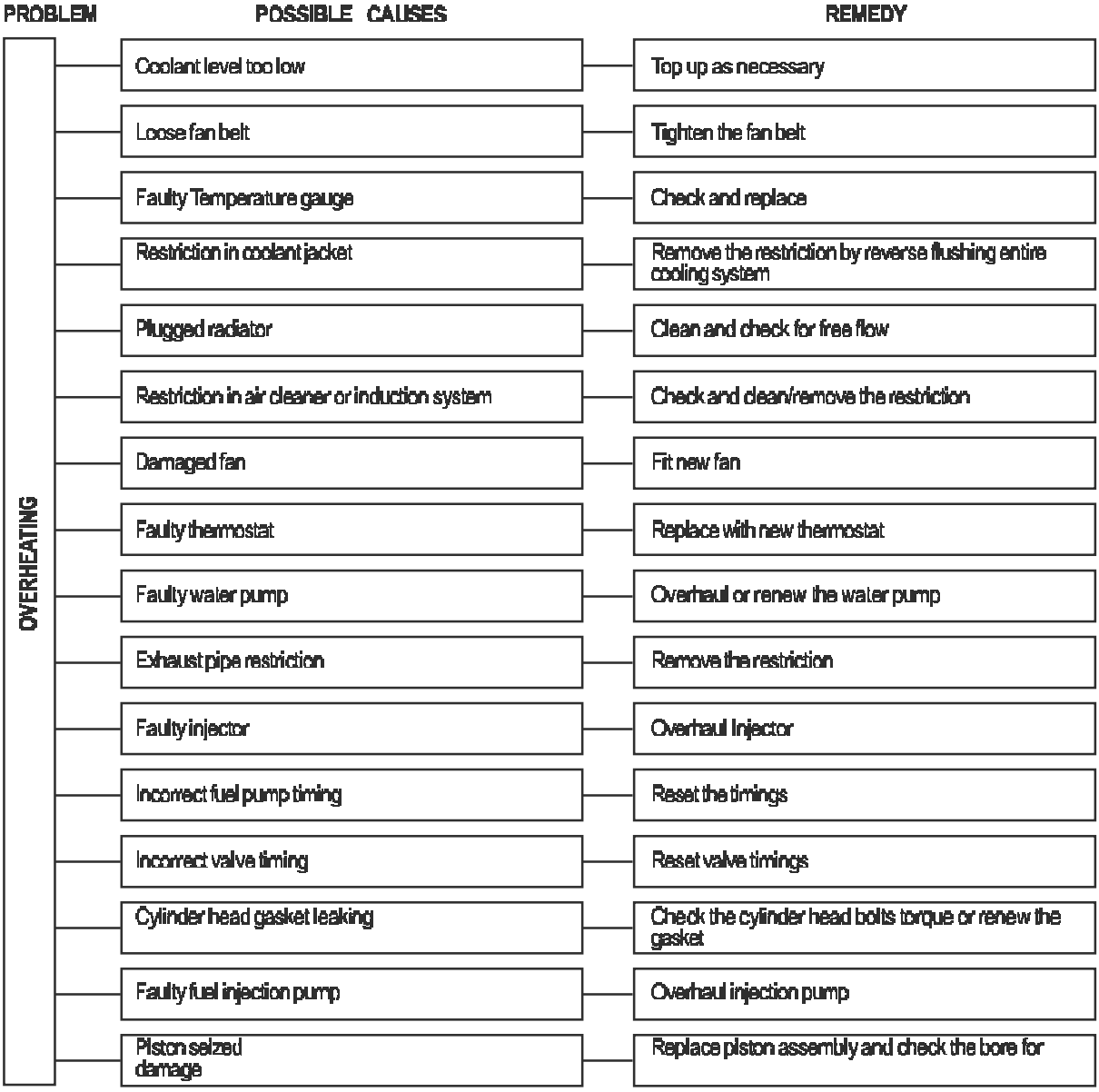
PROBLEM	POSSIBLE CAUSES	REMEDY
BLUE/WHITE SMOKE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Overfilled air cleaner oil or use of incorrect grade (wet type air cleaner)	Check the oil level and remove as necessary or of oil refill with correct grade oil
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Worn valve stems and guides	Renew valves and guides
	Piston seized damage	Replace piston assembly and check the bore for
LOW ENGINE OIL PRESSURE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Worn or damaged big end bearings	Renew the bearings
	Insufficient oil in sump	Top up as necessary
	Oil gauge faulty	Fit new gauge
	Oil pump worn	Renew oil pump
	Oil pressure relief valve faulty	Fit new relief valve
	Faulty suction pipe	Renew the pipe
	Chocked/Plugged oil filter	Replace with new filter
	Plugged sump strainer	Clean the strainer

PROBLEM	POSSIBLE CAUSES	REMEDY
ENGINE KNOCKS	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Incorrect type or grade of fuel	Drain and refill with correct grade of fuel
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and rest the adjustment
	Sticking valves	Replace valve with new standard or oversize, and / or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit ne pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Overfilled cleaner or use of Incorrect grade of oil (Wet type Air cleaner)	Check the level or drain out and refill with correct grade oil
	Worn or damaged big end bearings	Renew the bearings
	Piston seized damage	Replace piston assembly and check the bore for
	Broken valve spring	Replace new springs

PROBLEM	POSSIBLE CAUSES	REMEDY
VIBRATION	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Poor compression	See Problem – Poor Compression
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings.
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew with pipes of correct specifications
	Broken worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Piston seized damage	Replace piston assembly and check the bore for
	Faulty engine mounting	Check and redo the installation of engine
	Incorrectly aligned flywheel housing or flywheel	Check and align flywheel housing and flywheel
HIGH OIL PRESSURE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Inaccurate relief gauge	Check and renew gauge
	Pressure relief valve faulty	Fit new relief valve
STARTS & STOPS	Restriction Plugged fuel filter	Fit new filter
	Restriction in air cleaner or induction system	Remove the restriction
	Air in fuel system	Remove the air lock/Bleed air

PROBLEM	POSSIBLE CAUSES	REMEDY
ERRATIC RUNNING	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew the pipes of correct specifications
	Broken, worn-out or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Piston seized	Replace piston assembly and check the bore for damage
	Broken valve spring	Replace with new springs

ERRATIC RUNNING	Faulty stop control operation	Check the stop control cable movement and setting
	Resticted fuel feed/supply pump	Clean
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Plugged fuel filters	Chocked fuel filters
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air/Bleed air lock
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Poor compression	Renew piston rings or re-sleeve as necessary
	Plugged fuel tank vent	Clean the vent


PROBLEM
POSSIBLE CAUSES
REMEDY
OVERHEATING
Coolant level too low
Top up as necessary
Loose fan belt
Tighten the fan belt
Faulty Temperature gauge
Check and replace
Restriction in coolant jacket
Remove the restriction by reverse flushing entire cooling system
Plugged radiator
Clean and check for free flow
Restriction in air cleaner or induction system
Check and clean/remove the restriction
Damaged fan
Fit new fan
Faulty thermostat
Replace with new thermostat
Faulty water pump
Overhaul or renew the water pump
Exhaust pipe restriction
Remove the restriction
Faulty injector
Overhaul Injector
Incorrect fuel pump timing
Reset the timings
Incorrect valve timing
Reset valve timings
Cylinder head gasket leaking
Check the cylinder head bolts torque or renew the gasket
Faulty fuel injection pump
Overhaul injection pump
Piston seized damage
Replace piston assembly and check the bore for

Section E

CYLINDER HEAD

CYLINDER HEAD

The number of hours run has no bearing on when to overhaul the cylinder head because carbon. beyond a superficial coating does not form and accumulate in the combustion chambers and on the pistons as is the case with a gasoline engine.

Ease of starting and performance are the determining factors. Therefore the cylinder head should only be removed when it is absolutely necessary.

To Remove the Cylinder Head

1. Drain coolant from radiator and cylinder block.
2. Detach coolant connections from thermostat housing on front of cylinder head.
3. Remove air cleaner and hose connection.
4. Detach cold starting equipment connections (if fitted).
5. Disconnect the exhaust pipe from the engine exhaust manifold.
6. Disconnect closed breather hose from oil separator
7. Remove the injection pipes from the fuel pump to atomisers.

   Warning:- Cover the fuel pump delivery ports with suitable protective caps.
8. Remove atomiser leak-off pipes
9. Remove the atomisers (Use 24 mm tubular spanner as shown in Fig. E5 / E6)
10. Remove the cylinder head cover.
11. Remove the rocker shaft assembly (Fig. E1) by loosening rocker bracket setscrews.
12. Remove the push rods (provide tappet holding sticks in all tappet holes to hold the tappets in position while removal).
13. Remove the cylinder head setscrews.
12. Remove the cylinder head. Do not insert screwdriver or any other sharp instrument between the cylinder head and block. Place the cylinder head on a flat surface preferably wood to avoid damage.

To Remove the Valves

Depress the spring cap. and spring by means of a valve spring compressor and remove the two half conical collets.Remove the spring caps springs and washers thus freeing the valves for removal. The valves and valve seats should be reconditioned in the normal way using grinding compound or by means of specialised equipment.

The valve seat angle is 30° for inlet valve and 45° for exhaust valve.

Do not forget that the efficiency of a diesel engine depends largely on the maintenance of good compression. Contact between valve and seatings must therefore be the best possible.

Care should be taken to avoid unnecessary grinding away of the seat as the maximum clearance between the valve head and the cylinder head bottom face should not exceed ± 0.0079 inch (0.203 mm) for both the inlet and exhaust valve. This can easily be checked by means of a suitable gauge and feelers.

The SJ327 E engine have valve seat inserts fitted in the cylinder head for both inlet and exhaust valves (Valve seats are press fit in normal ambient condition).

The valve seats on 'SJ' Series engines are recessed into the cylinder head and a groov is cut where the proper valve seat ends in the mitred recess in the head. When valves have been reconditioned several times. it is possible that the valve may become masked by sinking too low in the cylinder head and in these circumstances the valve seat insert should be replaced.

During service if the valves were numbered and the cylinder head to be marked with corresponding numbers.

In factory manufactured engines the valves and seats are not numbered and where a valve is to be used again it should be suitably marked to ensure it is replaced in its original position.

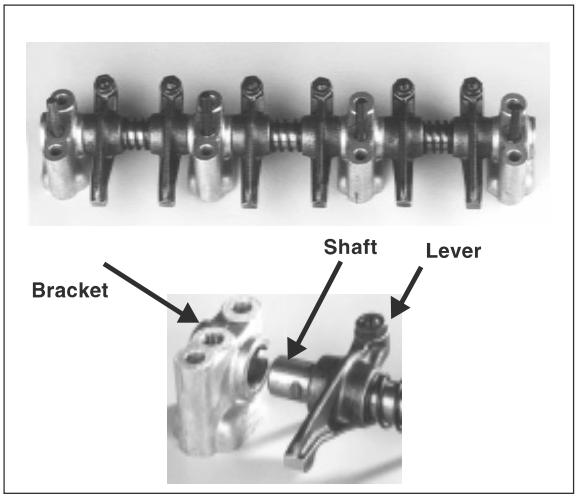


Fig. E 1 – Rocker Assembly

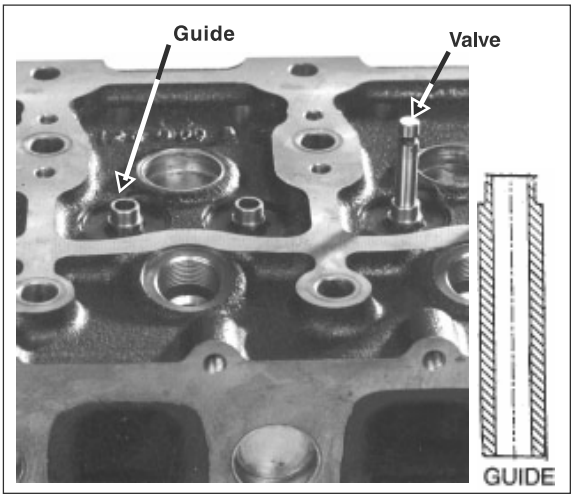


Fig. E 2 – Valve / Guide Protrusion

Rocker Levers and Bushes

Wash the rocker shaft assembly thoroughly in cleaning solvent.

Examine the rocker bushes for wear. The rockers should be an easy fit on the shaft without excessive side play.

If the rocker bushes are worn. it will be necessary to replace with a new bush and reamed to correct size.

When dismantling rocker shaft assembly (Fig. E1) make careful note of the order of assembly of the various parts. supports. springs and rockers so that re-assembly may be facilitated and that rockers are correctly placed and opposite of their respective push rods and valves as show in Fig. E 3.

Valve Guides

Examine the valve guides for wear. if necessary replace with new guides.

Clean the new guides. removing any burrs.

When pressing in a valve guide. care must be taken to ensure it is installed the correct way. Both the guides inlet and exhaust are interchangeable (Valves are not interchangeable). One end of this guide is stepped as shown in Fig. E2. This end should come on cylinder head top while inserting the guide. The stepped end of this guide should protrude 0.3917 / 0.3956 inch (9.95/10.05 mm) above cylinder head top face.

NOTE : *In production valve guide inner dia is finished by reaming along with valve seat in single operation.*

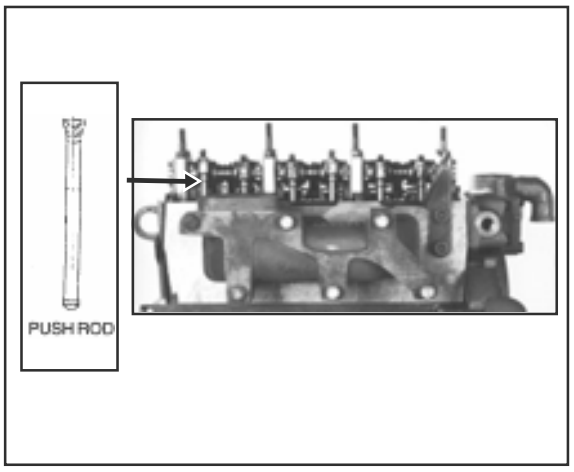


Fig. E 3 – Push Rod Location

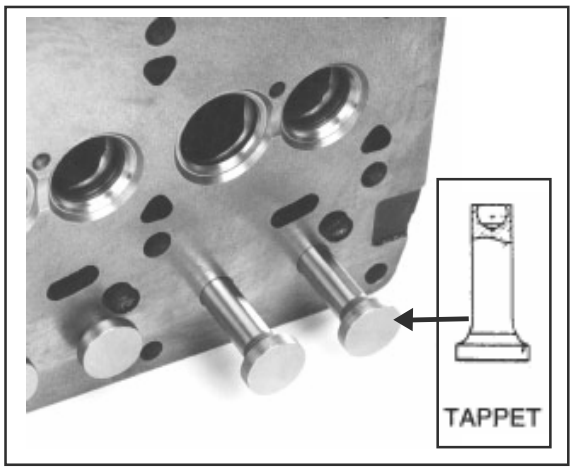


Fig. E 4 – Cylinder Head / Tappet

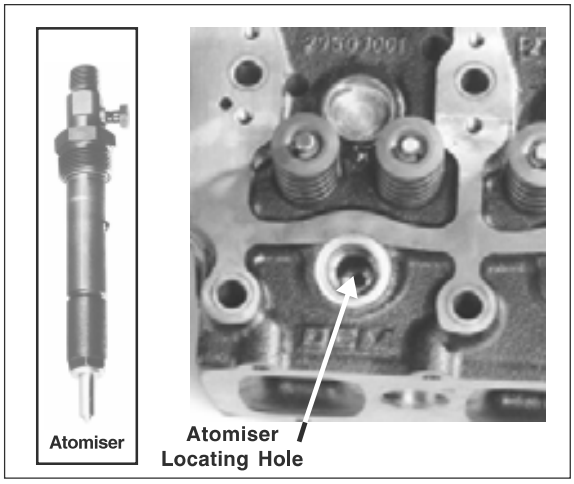


Fig. E 5 – Atomiser / Locating Hole

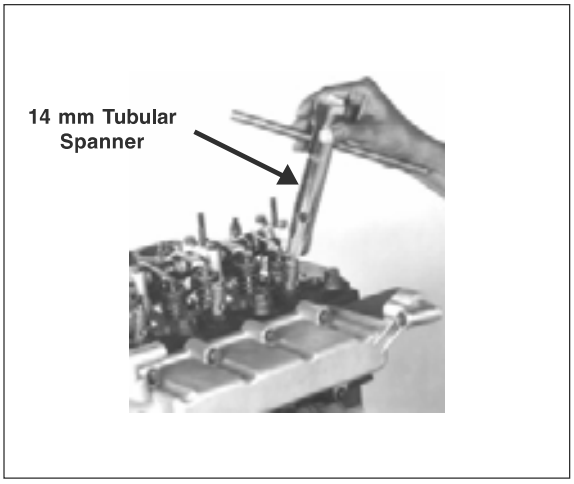


Fig. E 6 – Atomiser Tightening Tool

Tappets

The tappets slide in holes bored in the cylinder head as shown in Fig. E 4. The wear.under normal conditions. is negligible.

While fitting cylinderhead assembly with tappets use “tappet holding stick (magnetic)” to retain the tappets in position.

The valve tip clearance between valve tip and the rocker should be0.012 inch (0.30 mm) when the engine is cold or hot

When adjusting this clearance tighten locknut effectively. so that it does not loosen in service. (Ref. Fig. E 7).

General

All setscrews of the cylinder head and top face of the cylinder block should be examined for looseness. damaged threads etc. The cylinder head setscrews should also be examined to ensure the threads are not damaged/elongated.

NOTE : *All the setscrews should be replaced at the third attempt.*

All joint faces should be examined for pitting and defacement.

Wash out and thoroughly clean the coolant passages in the head subsequently drying out and finally cleaning with compressed air.

If the coolant jacket of the cylinder head shows signs of excessive scale a proprietary brand of descaling solution should be used.

If possible the cylinder head should be coolant tested for leaks with warm coolant at a coolant pressure of 4 bar (60 psi) for 1 minute.

IMPORTANT

The relative valve head depth however must afterwards be checked and if necessary corrected to

Fig. E 7 – Adjusting Valve Tip Clearance

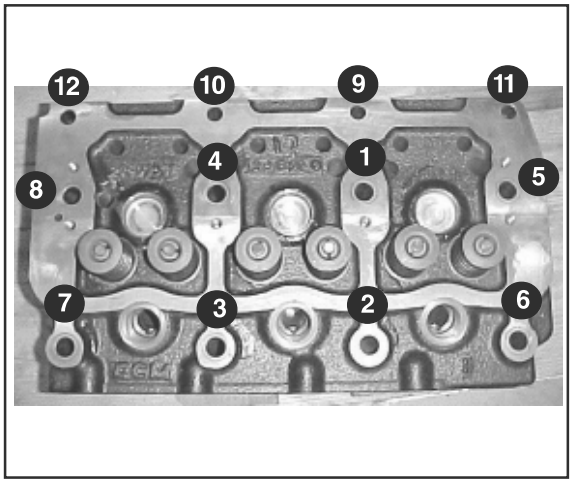


Fig. E 8 – Cylinder Head Tightening Sequence

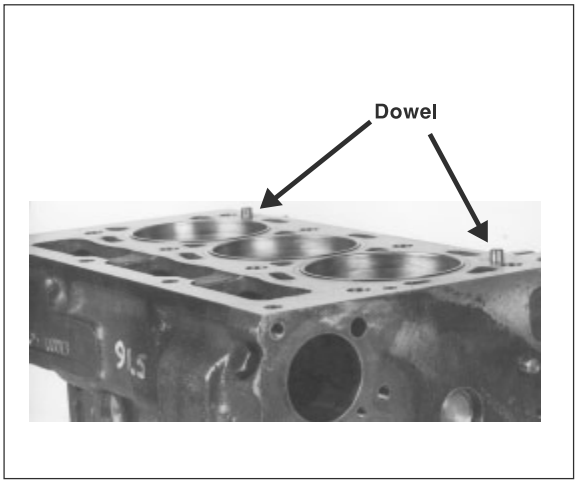


Fig. E 9 – Head Gasket Locating Dowel

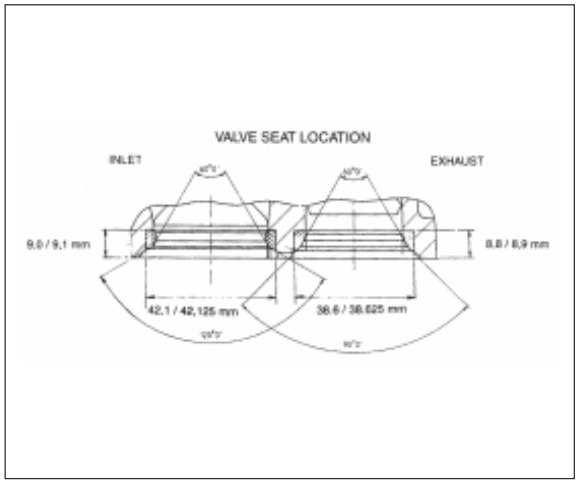


Fig. E 10 – Valve Seat Insert Location

conform with the limits quoted on section B.

Re-assembly and Replacing

Replace valves. washer. spring. collars and collets. taking care that the numbers on the valves correspond to the numbers stamped adjacent to the valve seats. (if Stamped)

On these engines one spring is fitted to each valve with a spring seating washer.

Before replacing the cylinder head it is extremely important to ensure that the faces of the cylinder block and cylinder head are perfectly clean.

A new cylinder head gasket should be used. The gasket is marked 'Front Top' to indicate how it should be fitted. Locating dowls are provided on cylinder block top surface

Non-retorque type gasket is being used. It should be fitted dry. This gasket does not require retorquing in Post-Delivery inspection.

When the underface of the cylinder head is perfectly clean. the head may be lowered into position on the locating dowels and the setscrews pulled down in the order shown in Fig E8. The cylinder head setscrews should be pulled down in stages according to torque and in the order .

Replace atomisers.

Replace the push rods. rocker shaft assembly. but before tightening the securing setscrews the rockershaft should be set so as to ensure locating the shaft (Ref. Fig. E1) by the four studs provided for rocker cover.

When the rocker shaft is correctly positioned. tighten the securing setscrews and set the valve tip clearance to 0.012 inch (0.30 mm). (cold or hot)

Provision is made in the cylinder head coolant outlet for the housing of a thermostat or blanking sleeve which must be fitted.

Adjusting Valve Tip Clearance

The three throw 120° crankshaft makes it necessary to adopt a slightly different sequence for tappet adjustment to the normally accepted procedure for four and six cylinder engines.

Valve tip clearances for both inlet and exhaust should be set to 0.012 inch (0.30 mm) in cold or hot.

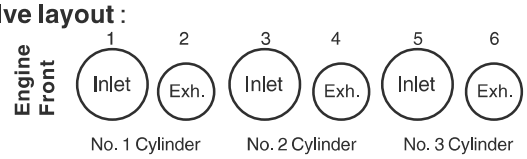
To adjust valve tip clearance on engine proceed as follows:-

(a) Rotate the crankshaft in clockwise direction and bring No. 3 Cylinder exhaust valve to full open position and set the valve tip clearance for No. 1 Cylinder inlet and exhaust valves. (*At this position No. 1 piston is at the end of compression stroke).*

(b) Then rotate the crankshaft in the same direction and bring No. 1 Cylinder exhaust valve to full open position and set the valve tip clearance for No. 2 Cylinder inlet and exhaust valves. *(At this position No. 2 piston is at the end of compression stroke).*

(c) Again rotate the crankshaft in the clockwise direction and bring No. 2 Cylinder exhaust valve to full open position and set the valve tip clearance for No. 3 Cylinder inlet and exhaust valves. *(At this position No. 3 piston is at the end of compression stroke).*

Valve layout :



Section F

PISTONS AND CONNECTING RODS

PISTONS AND CONNECTING RODS

The pistons are of special light aluminium alloy with a re-entrant bowl in the crown (Fig. F1). They are secured to the connecting rods by means of fully floating gudgeon pins which work in thin wall steel backed lead bronze lined bushes fitted in the small ends of the connecting rods. Circlips are provided in the pistons to secure the gudgeon pins in position. Three piston rings are fitted to each piston. All the piston rings are fitted above the gudgeon pin.

The connecting rod big ends are split at right angles to the axis of the rods. the caps being secured by two bolts and nuts.

Always ensure that big end nuts are replaced by new. once they are removed.

The big end bearings are of the thin wall type consisting of a thin steel shell lined with aluminium tin.

Ensure correct replacement of the pistons number 1 being at the front of the engine.

The connecting rods and caps. are also marked. On one side they are stamped with a number corresponding to their position in the engine.

To Remove Pistons and Connecting Rods

1. Remove cylinder head assembly (Ref. Section E).
2. Drain oil and remove sump
3. Turn the engine until number one connecting rod is at bottom center. Remove bolts and nuts securing the connecting rod cap.
4. Remove the connecting rod cap and both top and bottom half bearing shells.
5. The piston and connecting rod can then be pushed out of the top of the cylinder block.
6. Continue operations until all three pistons and connecting rods have been removed.
7. Keep all pistons connecting rods caps bearing shells bolts and nuts together as separate assemblies. each to each as marked.

To Remove Gudgeon Pins

Remove the circlips from the pistons using a pair of long nose pliers.

The gudgeon pins can now be removed and the connecting rods separated from the pistons.

To Fit New Small End Bushes

The small end bushes are a press fit in the connecting rods.

Press out the old bushes using a suitable press.

Remove any sharp edges around the connecting rod small end parent bores.

Press in the new bushes using a suitable dolly at the same time ensuring that the oil holes in the bushes coincide with the holes in the top of the connecting rods.

Ream out the new bushes in to suit their respective gudgeon pins and check for parallelism and twist.

To Assemble Pistons and Connecting Rods

If the original pistons are to be used again they should be re-assembled to their respective connecting rods. i.e. the piston stamped No.1should be fitted to the connecting rod stamped No. 1.

Pistons for the SJ 327E engine should be fitted with the offset of combustion bowl in the crown towards fuel injection pump side. (Offset of valve packets towards camshaft side).

Fig. F 1 – Piston

Assemble the connecting rod to the pistons and insert the gudgeon pin.

Fit the circlips to the piston. It is difficult to advise as to when new circlips should be fitted but in the event of an engine being in service for a lengthy period it is advisable that new circlips be used during re-assembly.

Fitting New Rings

The piston and rings should be thoroughly washed to remove any oil and grease.

Check piston rings for correct gap (Ref. Section B)

In worn cylinder bores the gaps should be checked at the unworn top of the bore. *after any carbon has been removed.*

Fit the rings to the piston in the following position (reading from the top of the piston).

1. Ring compression (Chromium inlaid. Half Keystone with 'Top' marked).
2. Ring compression (Cast Iron Taper land with 'Top' marked).
3. Conformable oil control Ring

When fitting new rings to original pistons clean out the piston ring grooves.

The pistons should be carefully examined for bruising of the ring grooves and to ensure that the rings move truly in their grooves. In addition the piston skirt should be examined and if there is any scoring the piston must not be used again.

To Fit Conformable oil Ring

1. Fit the helical coil spring onto the 3rd groove of the piston.
2. Insert the latch into the coil spring aligning both the ends.
3. Fit the outer C.I. ring over the coil spring Ensure coil spring gets seated properlyinside the ring groove.
4. Also ensure the coil spring latch is on the opposite side of the ring open end gap.

To Replace Pistons and Connecting Rods

Connecting rods and caps are plainly marked to indicate their original position in the engine. The numbers are stamped on that side of the connecting rod and cap which is machined to take the locating lips of the big end bearings.

Before fitting pistons. the cylinder bores should be given a liberal coating of clean lubricating oil.

When fitting pistons and connecting rods to the cylinder block and crankshaft ensure that the side of the connecting rod which is stamped with the number goes to the fuel pump side of the engine.

For SJ327 E engines ensure that the words "F" marked on the piston crown is towards the front of the engine. (Offset of combustion bowl in the crown toward fuel injection pump side).

Insert the pistons and connecting rods into the cylinder bores from the top. ensuring the piston and rod stamped No. 1 are fitted into No. 1 bore and No. 2 into No. 2 bore and so on commencing from the front of the engine.

To minimise the possibility of breaking piston rings it is advisable to use a piston guide. Take care not to damage the rings. Should the piston accidently drop partly into the cylinder bore and is held suspended by a piston ring it must be taken out again and the ring examined to see if it is cracked or broken.

Turn the crankshaft until the appropriate crankpin is at bottom center pull the connecting rod to the crankpin and insert the half bearing.

Fit the cap and cap half bearing ensuring that the markings on connecting rod and cap coincide.

The nuts used on the big end bolts should not be used a second time but should be replaced by new whenever they are removed.

Tighten the connecting rod nuts using a torque wrench set to the tension given on Section B.

Rotate crankshaft by hand and note that all parts move freely.

Check the piston height in relation to the top face of the cylinder as described below.

Fig. F 2 – Piston Ring Groove

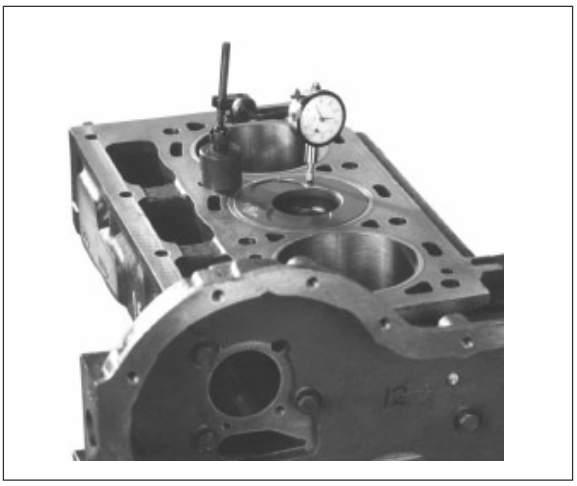


Fig. F 3 – Piston Height Measurement

Fitting New Pistons

An important point to note is that when the crankpin is at top dead center the crown of the piston must be 0.0059/0.0023 inch (0.150 / 0.060 mm) above block surface.

Pretopped pistons are being used with letter "L" or "H" marked on piston crown for identification

"L" – Low grade / "H" – High grade.

(Note : This grade does not refer to material grade.)

To determine the piston level. the piston assembly and connecting rod should be fitted to the cylinder block and crankshaft as previously described.

When assembled. turn the crankshaft to bring the piston to T.D.C. and check the distance between the piston crown and the top face of the cylinder block as shown in Fig. F.3.

Carry out this operation with each new piston in turn. If necessary it has to be replaced by another new piston. The piston should not be machined for any reason in an attempt to correct this height.

The distance between the cylinder block face and piston crown should now be checked to ensure the limit has been maintained when the piston is at Top Dead Center (TDC).

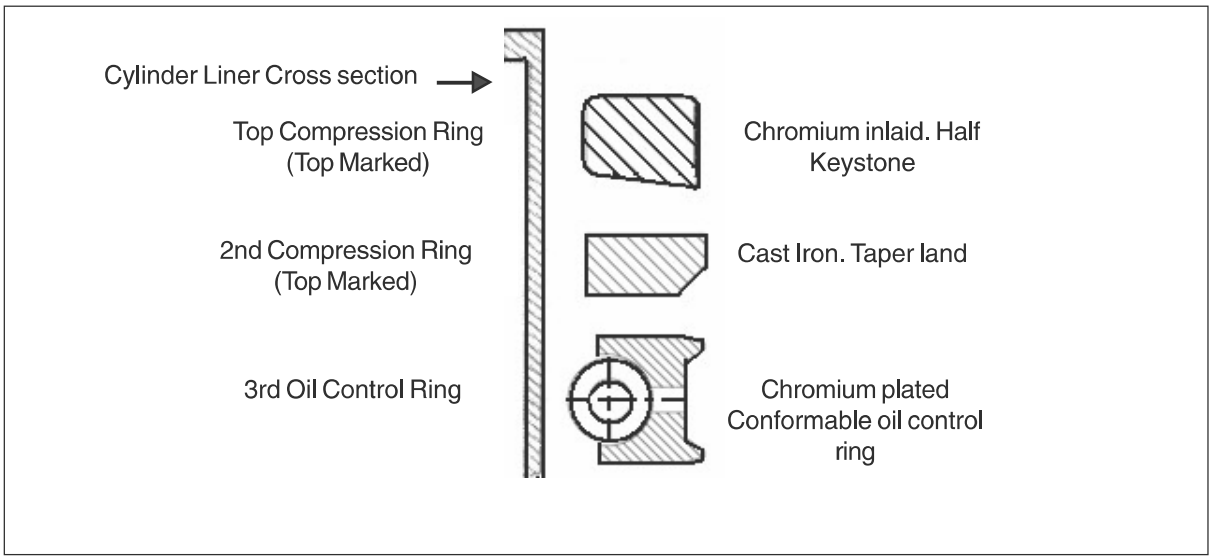


Fig. F 4 – Ring Layout

Section G

CYLINDER BLOCK AND LINERS

CYLINDER BLOCK AND LINERS

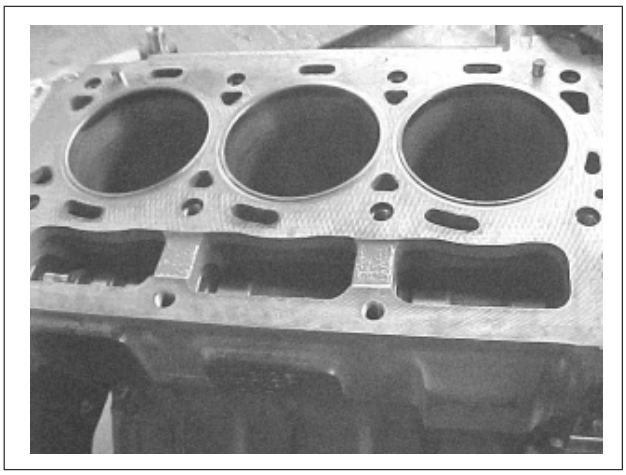


Fig. G 1 – Cylinder Block with Liner (SJ 327 E)

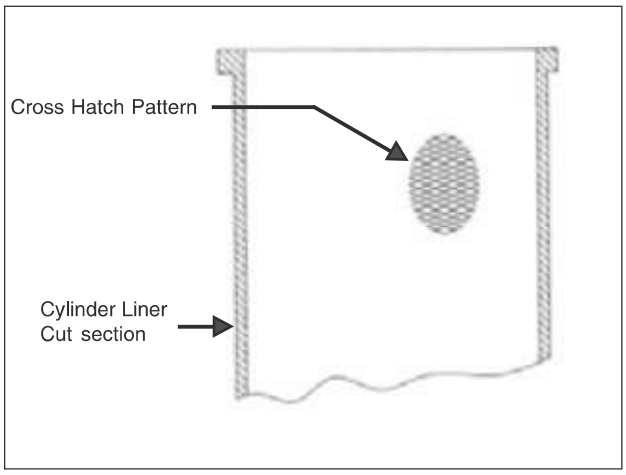


Fig. G 2 – Cylinder Liner / Hatch Pattern

The cylinder block is fitted with renewable thin wall cast iron dry cylinder liners. The cast iron cylinder liners are an interference fit and require boring and honing to size after fitting. The liner without flame ring is applicable to SJ 327E engines as shown in figures G1 / G2. The cylinder head gasket is non-retorque type.

Cylinder liners fitted to SJ327 Eengines are **not recommended to rebore.** When they are worn to an extent whereby engine performance is affected. they should be renewed.

To Remove Liners

1. Remove cylinder head as detailed in Section E.
2. Remove the piston and connecting rod assemblies crankshaft and all component parts of the cylinder block as detailed in the appropriate sections of this manual.
3. Press or draw the liners out through the top of the cylinder block ensuring no damage is done to the parent bores (cast iron production liners are an interference fit and should be removed with a heavy duty press).

Preparation for Fitting New Liners

Great care must be taken in handling. transit and storage of new liners.

After removal of the old liners. the parent bore must be thoroughly cleaned both in the top recess of the liner flange and in the parent bore itself.

A check must be made to ensure that the whole areas of contact with the liners in the cylinder block are free from burrs. corrosion or damage. Remove any burrs present.

Ensure that the new liner is thoroughly clean before fitting. If cleaning fluid is used to wash the liner. it is important that the liner be thoroughly dried and well oiled before fitting.

Throughout the whole operation extreme cleanliness is essential as the entry of the smallest particle of grit or other foreign matter is sufficient to cause local distortion of the liner bore.

To Fit New Liners (Per finished Liners)

1. Lubricate the outside diameter of the liners with clean oil which should be applied by means of a pressure can. The use of a brush is not recommended.
2. Press or draw in the new liners using a suitable shouldered metal disc ensuring that the flanges at the top of the liners do not foul the counter-bore at the top of the parent bore thus causing distortion at the top of the internal diameter of the liner.

When fully seated the top face of the liner flange should be 0.0031 / 0.0011 inch (0.080/0.030 mm) above the top face of the cylinder block. (Ref. Fig. G3).

Pre finished liners (as used in factory production) are an interference fit in the cylinder block as compared with the transitional fit of pre-finished liners and require

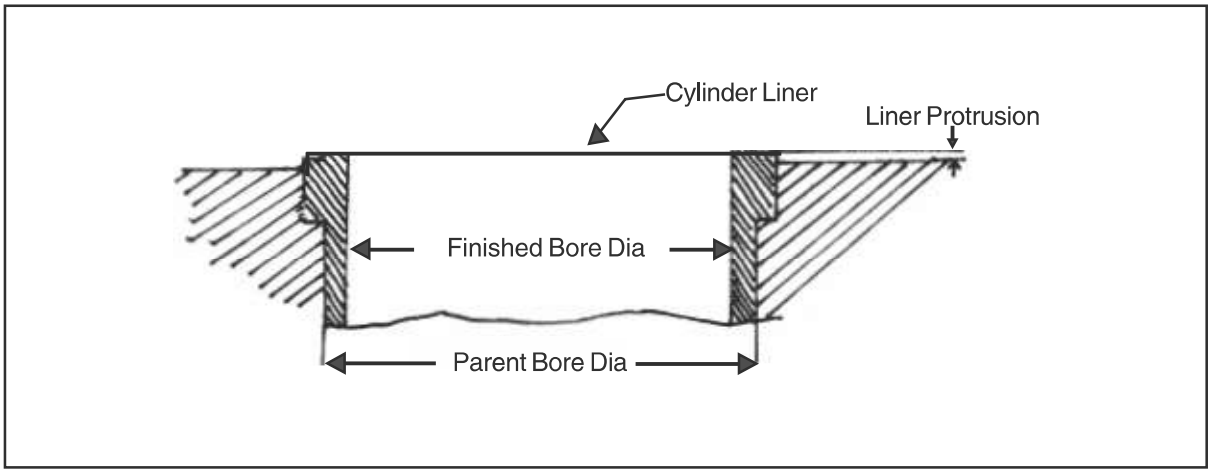


Fig. G 3 – Cylinder Block / Liner

to a diameter of 3.741 / 3.740 inch (95.022 / 95.00 mm) for SJ 327 E engines.

Each new liner should be checked in three positionstop center and bottom; the readings being taken transversely and parallel to the center line of the cylinder block at each position.

Having fitted the new liners the remainder of the re-assembly operations are a reversal of the removal procedure.

Section H

CRANKSHAFT AND MAIN BEARINGS

CRANKSHAFT AND MAIN BEARINGS

The crankshaft runs in four pre-finished re-placeable shell bearings lined with aluminium tin.

The crankshaft is fitted with two cast iron counter weights. one at the front crank web and one at the rear crank web to give full rotating balance.

The main bearings are located in position by tabs fitting into slots machined in the bearing housings.

The seal at the rear end of the crankshaft is a cassette type seal fitted in a one-piece housing

Fitting New Main Bearings and Thrust Washers

Under normal circumstances. by the time the main bearings and thrust washers require renewing the crankshaft will need to be removed for regrinding. However if for any reason one or more of the bearings or thrust washers have to be renewed or removed for inspection. this can be carried out without removing the crankshaft from the engine.

1 . To remove a main bearing take off the cap of the bearing in position. For the rear main bearing cap. see (1) in next column.

2. Do not remove more than one bearing cap at a time.

3. Loosen the remaining bearing cap setscrews one or two turns.

4. Remove the lower half of the bearing from the bearing cap.

5. With a suitable piece of wood push out the top half of the bearing by rotating it on the crankshaft. applying the tool to the side opposite the bearing lip. The locating lips are on the camshaft side of the engine.

6. Inspect the bearing shells and if they require renewing insert a new half bearing in the top inserting the plain end first. Fit new half bearing to cap.

7. Replace cap and tighten setscrews lightly before proceeding to the next bearing.

8. Having replaced the bearing and caps pull down the setscrews with a torque wrench set to the tension given on Section B

The thrust washers fit in recesses provided on either side of the rear main bearing housing and cap.

1. To renew the thrust washers. remove the rear main bearing cap. Before doing this it will be necessary to release the rear end oil seal and housing

2. Remove the two bottom half thrust washers from the main bearing cap.

3. The two top half thrust washers can be removed by sliding them round from one side with a piece of wood or similar material and rotating them until they can be removed.

4. To fit new thrust washers lightly coat the two upper halves with lubricating oil and slide in the recesses provided on either side of the rear main bearing housing. The steel side or flat surface of the thrust washers should be towards the bearing housing.

5. Renew the main bearing cap "O" rings. Lightly coat around the grooves machined in the cap butt faces with jointing compound and ensure that the grooves are free of jointing compound.

6. Place the two lower halves of the thrust washers on either side of the rear main bearing cap and replace the cap.

7. The bearing cap securing setscrews should be pulled down with a torque wrench set to the tension given on Section B Check crankshaft end float.

8. Refit the rear end oil seal housing and then cassette type seal using special tool.

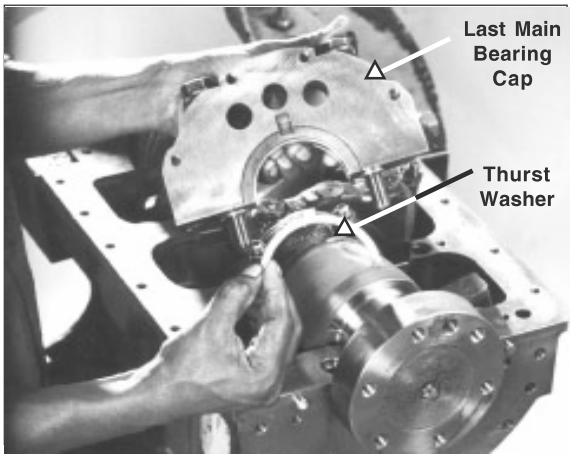


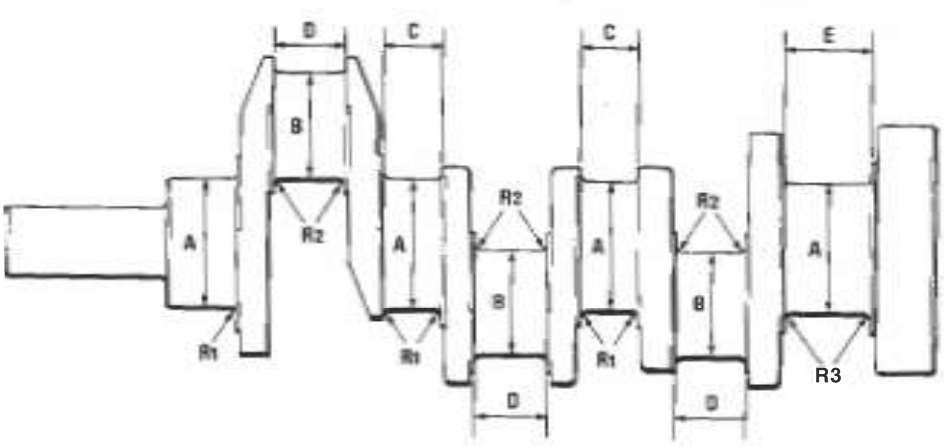
Fig. H 1 – Crankshaft Thurst Washer

To Remove Crankshaft

1. Remove sump and lubricating oil pump (Ref. Section L).
2. Remove water pump (Ref. Section M).
3. Remove crankshaft pulley.
4. Take off timing case front cover and remove idler gear.
5. Remove starter motor. flywheel & flywheel housing. When removing the flywheel. fit two guide studs in the crankshaft flange for support.
6. Remove connecting rod caps and big-end bearings.
7. Remove the rear end oil seal and housing.
8. Remove setscrews and remove main bearing caps and half bearings.
9. Lift out crankshaft.

Should it be necessary to replace the crank-shaft gear. it should be ascertained that the scribed timing mark is to the front when the gear is fitted. The distance piece between the gear and the crankshaft should be fitted with the chamfer to the inside.

If the main bearings are to be used again they should be suitably marked so that they may be installed in the same position from which they were removed.



	0.0098 inch (0.25 mm)	0.020 (0.51 mm)	0.0299 inch (0.76 mm)
	Undersize	**Undersize**	**Undersize**
A.	69.56/69.58 mm	69.30/69.32 mm	69.05/69.07 mm
B.	56.86/56.88 mm	56.60/56.62 mm	56.35/56.37 mm
C.	31.184 mm (maximum)		
D.	40.00 mm (maximum)		
E.	47.27 mm (maximum)		
RI	3.18 / 3.56 mm all journals **Except Rear** – 3.97 / 4.22 mm (R3)		
R2	4.76 / 5.16 mm all crank pins		

Surface finish of crankpins. journals and fillet radii 0.4 / 0.2 microns C.L.A.

Fig. H2 – Crankshaft

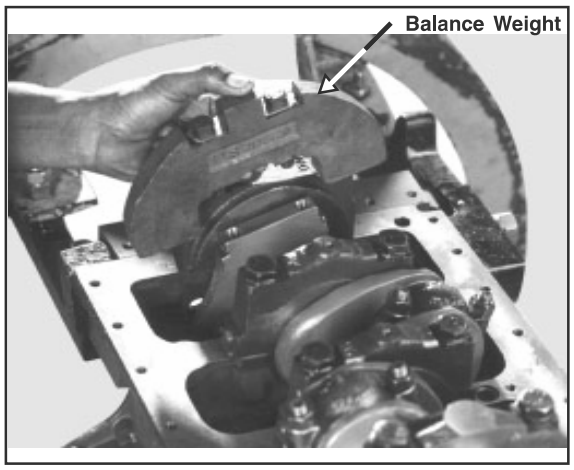


Fig. H 3 – Balance Weight

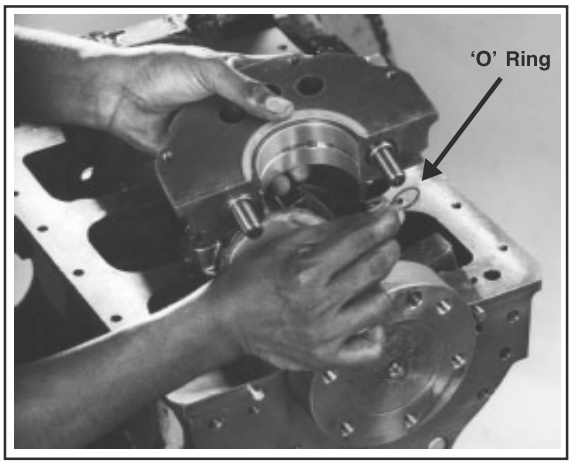


Fig. H 4 – Main Bearing Cap 'O' Ring

Balance Weights

Should it at any time be necessary to replace crankshaft balance weights these are normally supplied in wired pairs and must be fitted as a pair. Should a single balance weight require replacing this must be done selectively so that there is no greater weight variation than 1 oz (0.028 Kg.) between individual weights. (Ref. Fig. H3)

Regrinding the Crankshaft

Before proceeding to regrind the crankshaft. the following points should be checked to ensure it is suitable for further machining.

(a) The crankshaft should be crack-detected before regrinding. It must of course be remembered to demagnetise the crankshaft after crack-detecting. in order to remove any polarisation which may be present.

(b) The main journal and crankpin diameters should be checked to ascertain the next appropriate under size to which the crankshaft can be-reground i.e. 0.0098 inch (0.25 mm), 0.020 (0.51 mm) , 0.0299 inch (0.76 mm) (Ref. Fig H 2).

If the crankshaft requires to be reground below 0.76 mm it is recommended that a new crankshaft is fitted.

During regrinding. all the limits must be adhered to. and the main journals and crankpins must be free from grinding marks.

NOTE: *It is important that the RADII on the main journals and crankpins are maintained. If these are neglected. a fatigue fracture is liable to occur.*

After regrinding. the sharp corners on the oil holes should be removed and the crankshaft crack-detected again and demagnetised.

Replacing Crankshaft

1. Ensure that all oil-ways are clear.
2. Check main bearing setscrews for stretch or damage to threads. Affected setscrews must be scrapped.

   In no case should setscrews other than those supplied by the engine manufacturer be used as they are of special heat treated highgrade steel.
3. Clean bearing housing and place top half bearing in position.
4. Place crankshaft in position.
5. Lightly smear the two upper thrust washers with lubricating oil and slide in to the recesses provided on either side of the rear main bearing housing. with the steel side or plain surface of the washers towards the housing. (Ref. Fig. H1)
6. Fit lower halves of main bearings to bearing caps and place in position ensuring that the thrust washers on No. 4 main bearing cap are fitted correctly.
7. Renew the rear main bearing cap "O" rings (Fig. H 4).
8. Lightly coat the rear main bearing cap butt faces with Jointing Compound. only coat outboard of the grooves machined in the cap butt faces and ensure that the grooves are free from jointing compound.
9. When replacing the main bearing caps. ensure that they are fitted in their respective positions. also that they are fitted the correct way round. The caps are numbered. No. 1 commencing at the front of the engine. Each cap is also marked with a serial number and when fitted. this number should read in line with the serial number stamped on the cylinder block bottom face.

Crank shaft Rear end Oil seal Cassette

Fig. H 5

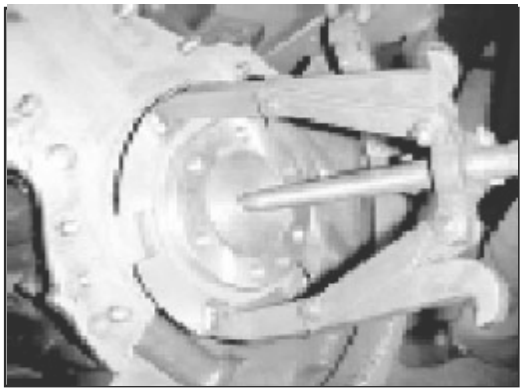


Fig. H 6

For final tightening of the setscrews, a torque wrench should be used, set to the tension given on Section B

When refitting the crankshaft pulley, ensure that the pulley setscrew is tightened to the correct torque as given on Section B .

Re-assemble engine as required and to the instructions given for the various operations.

Cassette Type Rear end Oil Seal :

It provides a sealing system by unitizing bonded PTFE wafer type sealing lip with a steel flanged (wear) sleeve.

Removal Procedure :

- Loosen all the fixing bolts of the rear end oil seal retainer (Seal Housing).
- Unscrew all the fixing bolts and remove the retainer (Seal Housing).
- Position the 3 jaws / split rings of the removal tool over the groove / flange of the oil seal – Ref. Fig. H5
- Adjust the central screw (removal screw) in such a way that the tip rests against the center of the crankshaft flange.
- Ensure that the jaws / split rings are properly positioned so that it does not slip out of position while removing the oil seal – Ref. Fig. H6.
- Drive the removal screw forward so as to pull the oil seal gradually.
- Take out the removal tool.
- Oil seal removal is complete

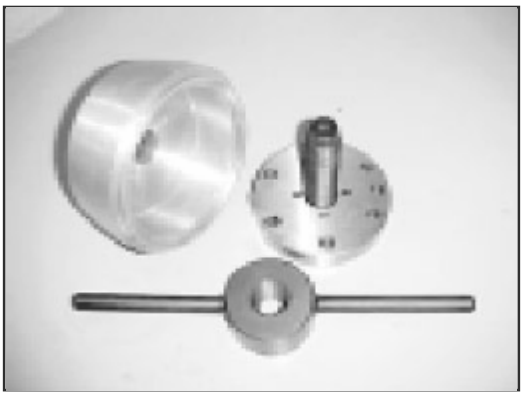


Fig. H 7

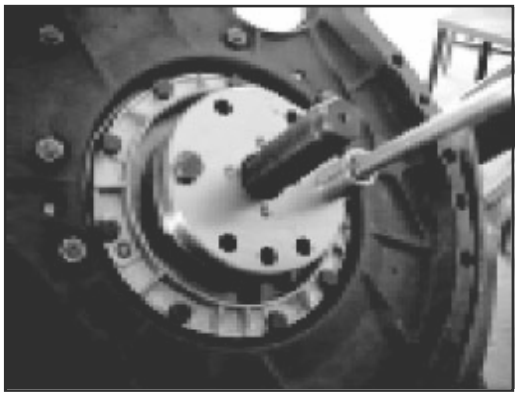


Fig. H 8

Fig. H 9

Fig. H 10

Fitment Pocedure :

- Check for crankshaft end float.
- Assemble rear end oil seal retainer housing to Pt. No. : 37424611 onto the cylinder block rear face with joint and tighten all bolts as per sequence (Torque 20 lbf.ft or 27 Nm) using a torque wrench.
- Ensure proper torque tightening on all the bolts
- Check the bore of the oil seal retainer housing and crankshaft sealing surfaces. Remove any surface burr, dust, dirt or metal chips before seal installation.
- Verify that the oil seal and installation tool are available and are in good and clean condition.
- Dismantle installation tool (Ref. Fig.H7).
- Position the adaptor plate and mount it on the crankshaft palm face using two screws and tighten the screws (Ref. Fig. H8).
- Apply molykote – 111 compound uniformly on the OD of the crankshaft flange and ID of the oil seal.
- Position the new oil seal over the adaptor. (Seal surface with the part number identification should be positioned towards the operator Ref. Fig. H9).
- Position the installer plate over the oil seal (Ref. Fig. H10)
- Position the Hexagonal nut over the adaptor plate stud and drive the same until the installer plate bottoms out on the seal retainer housing face (Ref. Fig. H10).
- Remove the Hexagonal nut, installer plate and adaptor plate.
- The seal installation is now complete.

Section J

TIMING CASE AND DRIVE

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TIMING CASE AND DRIVE

The camshaft is carried high up on the off side of the cylinder block.

It is driven from the front of the crankshaft by means of gears.

The timing gears are enclosed by a Cast Iron/Timing case and Aluminium timing cover.

To Remove the Timing Case Cover

1. Loosen the alternator mounting bolts and remove the fan belt.
2. Loosen off the hose clamps on the hoses fitted to the water pump and remove the water pump.
3. Remove the setscrew of crankpulley and washer, the setscrew is of a normal right hand thread into the crankshaft.
4. Remove the crankshaft pulley.
5. Remove the alternator
6. Remove the brackets and adjustable linkage.
7. Remove the timing case cover setscrews Two long bolts pass through the timing case to secure a cover at the rear of the timing case, blanking off the power take off bore.
8. Remove the timing case cover taking care not to damage the crankshaft front oil seal which is located in the timing case cover.

To Renew the Crankshaft Front Oil Seal

1. Carefully extract the oil seal from the timing case cover using a suitable press.
2. Locate a new seal in the timing case cover with the lip of the seal towards the inside of the cover.
3. Seals encased with a metal rim should be coated with jointing compound before being pressed into the timing case cover bore.
4. Press the new seal in position using a suitable dolly to ensure the seal is square in the bore of the cover.

To Replace the Timing Case Cover

1. Clean the jointing faces of the timing case and its cover using a new joint, refit the cover and water pump taking care not to damage the front crankshaft oil seal as the cover is placed over the crankshaft front end.
2. For purposes of centralizing the cover around the crankshaft, fit the pulley to the crankshaft and fix the position of the cover to the timing case by two or three setscrews. Remove the pulley and refit all the setscrews to the timing case (Centralising tool could be used instead of crankpulley).
3. Replace the crankshaft pulley, washer and dognut or setscrew.
4. Refit the hoses to the water pump and tighten the clamps.
5. Replace the alternator bracket, alternator and fan belt and tighten the alternator retaining bolts.

Timing Gears

The camshaft and the fuel pump gears are driven by the crankshaft gear through two idler gears mounted on hubs, bolted to the front of the cylinder block. All the gears are suitably marked during production to facilitate retiming the marks being in line when No. 1 piston is at top dead center on its compression stroke (Ref. Fig. J4). It will be appreciated that these timing marks will not align at every rotation of the crankshaft where No.1 piston is at T.D.C. compression.

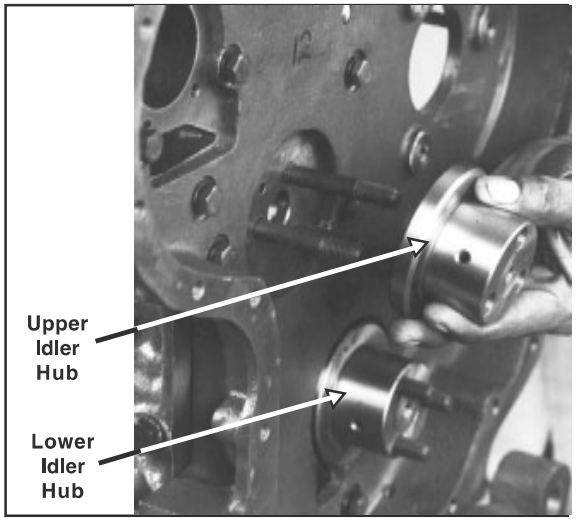


Fig. J 1 – Timing Case, Idler Hub

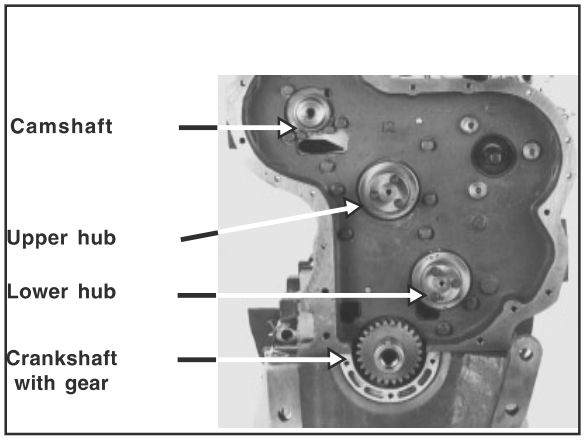


Fig. J 2 – Timing Case without gears

If it is necessary to replace any of the timing gears, ensure that there is a minimum backlash of 0.0031 inch (0.08 mm) (Ref. Fig. J4).

The backlash between the crankshaft gear and oil pump idler gear should be 0.0074 / 0.0125 inch (0.19 to 0.32 mm) (Ref. Fig. J5).

To Remove the Idler Gears and Hubs

1. Remove the banjo bolt securing the oil pipe to the lower idler gear hub.
2. Release the banjo bolt and remove the oil pipe by withdrawing it from the back of the timing case.
3. Knock back the tab washers and remove the three securing nuts.
4. Remove the locking washer and idler gear retaining plate.
5. Remove the lower idler gear.
6. Remove the upper idler gear in the similar manner.
7. The idler gear hubs may now be removed from the studs located in the front of the cylinder block (Ref. Fig. J1).
8. Where necessary, replace idler gear bushes (if fitted). These should be finished by boring to 1.999 / 2.0007 inch (50,79 / 50,82 mm) and faced to 1.1865 / 1.1857 inch (30,137/30,163 mm) overall width.

To Replace the Idler Gears and Hubs

1. The studs on which the hubs locate, are so positioned that the hubs will fit in one position only and the boss at the rear of the hub locates in the machined face of the cylinder block. Fit the lower and upper idler gear hubs which are inter-changeable.

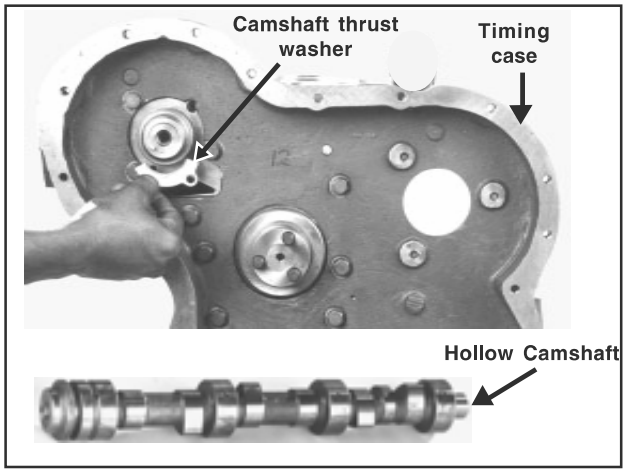


Fig. J 3 – Camshaft / Thrust washer

2. Remove the rocker cover and release the rocker assembly.
3. Turn the crankshaft and bring No. 1 piston to T.D.C. i.e. with the key-way at the front of the crankshaft uppermost.
4. Replace the two idler gear ensuring that all timing marks align.
5. Replace the idler gear retaining plates, which will only fit in one position on the studs. The lower retaining plate has a hole to take the oil pipe banjo bolt.
6. Fit new locking washers and replace the securing nuts. Bend the tab washers to lock the nuts.
7. Replace the oil pipe and banjo bolt to the lower idler gear retaining plate. The closed end of the oil pipe must locate in a hole in the back of the timing case immediately above its lower idler gear.
8. Secure the rocker assembly, adjust the valve tip clearance and fit the rocker cover.

To Remove the Camshaft Gear

1. Release and remove the 12 mm securing setscrew from the camshaft.
2. The camshaft gear may now be removed from the camshaft

To Replace Camshaft Gear

1. Remove upper idler gear and release the rocker assembly to facilitate turning of camshaft. On the spigot of the camshaft is a dowel pin ,ensure that it aligns with the dowel hole in the cam shaft gear.
2. Replace and secure the camshaft setscrew using torque wrench.
3. Fit idler gear, aligning all timing marks and secure the rocker assembly and reset valve tip clearance.

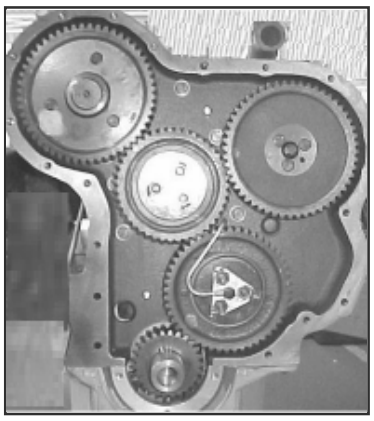


Fig. J 4 – Timing gears

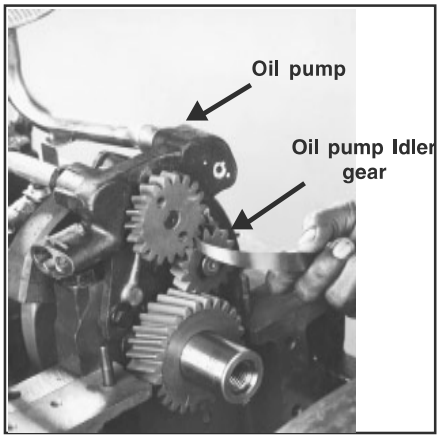


Fig. J 5 – Oil Pump gear backlash

To Remove the Fuel Pump Gear

1. Remove the idler gear.
2. Release and remove fuel pump gear securing nuts.
3. Remove fuel pump gear, taking care not to damage the dowel.

To Remove the Camshaft

1. Remove the rocker shaft assembly as previously described.
2. Remove the timing case cover as previously detailed.
3. Turn the crankshaft until all the timing marks are aligned.
4. Lift all the tappets and keep them in lift position using tappets holding sticks, remove the camshaft gear and remove the camshaft thrust washer and gear from its location in the cylinder block taking care not to damage the journals, cams and tappets.

To Replace the Camshaft

1. Lift all the tappets and keep them in lift position using tappet holding sticks and carefully fit the camshaft and gear continually turning the camshaft. Take care not to damage the journals, cams and tappets. Fit camshaft thrust washer. Make sure the timing marks on the idler gear and camshaft are aligned correctly.
2. Replace timing case cover.
3. Refit the rocker shaft assembly with push rod and reset valve tip clearance.
4. Replace cylinder head cover.

Camshaft Thrust

The camshaft end float is taken up by camshaft thrust washer (sintered) which is retained by two setscrews (Ref. Fig. J3).

To Remove the Timing Case

1. Remove the timing case cover as previously detailed.
2. Release and remove the rocker shaft assembly.
3. Remove the sump as explained under “Lubricating System” (Section L).
4. Remove timing case bottom cover.
5. Release the banjo bolt fitted on lower idler hub and remove the oil pipe by withdrawing it from its locating hole in the back of the timing case.
6. Unscrew the retaining setscrew and remove the locking washer, idler gear and spigot.
7. Lift all the tappets and keep them in lift position using tappet holding sticks and remove the camshaft gear, thrust washer and camshaft taking care not to damage the cams or bearing journals.
8. Release the three setscrews and remove the driving gear from the fuel pump.
9. Remove all cables and pipes from the fuel injection pump. When removing the high pressure pipes from the pump, release the pipes at the atomiser end and remove the pipes.
10. Unscrew and release the three nuts, spring washers and plain washers securing the fuel pump flange to the timing case and remove the fuel injection pump. Ensure that all inlet and outlet connections of the fuel injection system are effectively sealed against the ingress of dust and dirt by the use of suitable caps and plugs.

11. Remove the setscrews and washers securing the timing case to the block and with a light tap remove the timing case from the cylinder block.

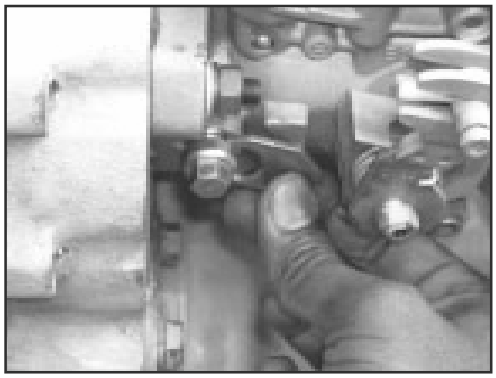
To Replace the Timing Case

1. Fit a new gasket to the cylinder block front face and replace the timing case.
2. Replace timing case bottom cover ensuring it is correctly aligned with the front face of the timing case.
3. Secure the fuel injection pump to the back of the timing case matching the scribed marks (if provided)
4. Turn the engine crankshaft until No. 1 piston is at top dead center (key on the front of the crankshaft vertically upwards)
5. Fit the fuel pump gear to the fuel pump, locating the dowel between the gear and fuel pump adaptor.
6. Lift all the tappets and keep them in lift position using tappet holding sticks and replace the camshaft, thrust washer and its gear.
7. Replace the idler gears on their hubs with the timing marks on the crankshaft gear, fuel pump gear, camshaft gear and idlers in line.
8. Replace the sump as described in the “Lubricating System”.
9. Replace the timing case cover.
10. Refit all fuel pipes and controls.

To Remove the Fuel Injection Pump

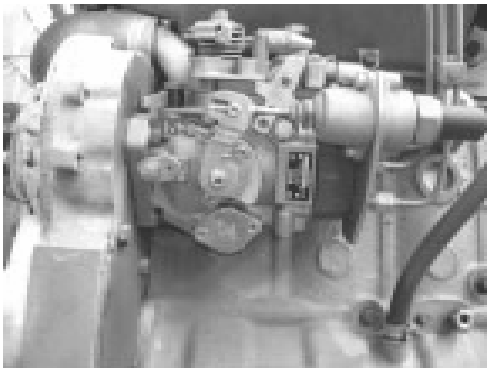
The fuel injection pump is secured to the back of the timing case on the left side of the engine and the fuel pump driving gear is securely attached to the shaft of the pump by an adaptor and three setscrews. The location of the gear to the fuel pump shaft adaptor is determined by a dowel.

On the timing case front cover is a small inspection cover and removal of this cover gives access to the setscrews securing the driving gear to the fuel pump.

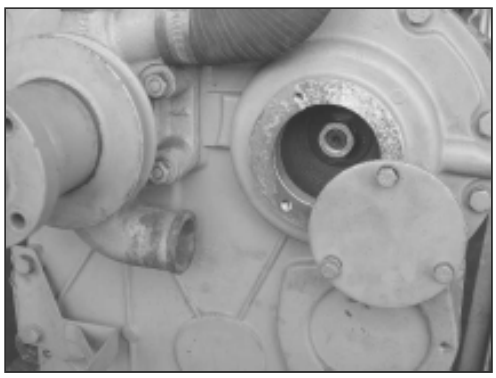


1. Lock the fuel injection pump camshaft by using pump locking screw.

2. Rotate the crankshaft pulley and align the spill timing mark with bracket.

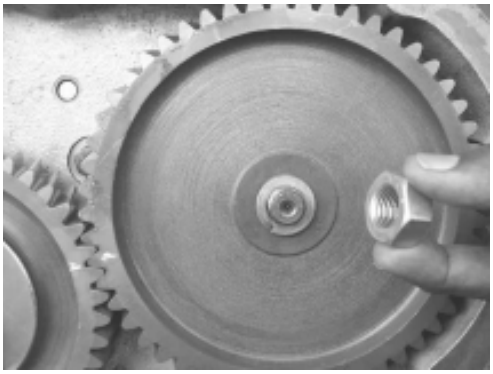


3. Remove the fuel injection pipe lines which is connected to fuel injection pump.



4. Remove inspection cover mounting bolts.

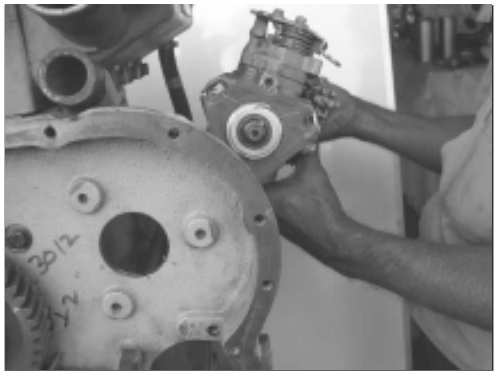
5. Remove the pump gear nut.



6. Remove the flange mounting nuts from the rear face of the timing case.
7. Remove the fuel injection pump from the engine.

Refitment:

8. Refit the fuel injection pump and tighten the flange mounting nuts.
9. Align the pump cam shaft gear with upper idler gear timing mark and tighten the pump gear nut to a torque of 55 lbf.ft (75 Nm).
10. Refit the timing case cover.
11. Adjust the pump timing refer section K.
12. Release the pump locking screw from the fuel injection pump.



Section K

TIMING

TIMING

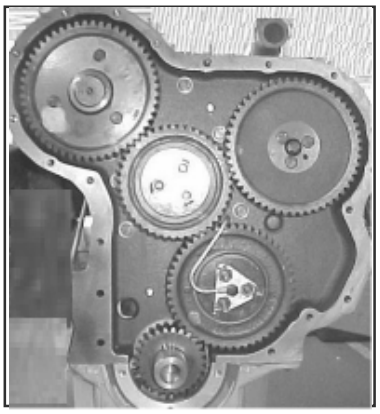


Fig. K.1 – Timing Gear Marks

The timing or the resetting of the timing can be simply and quickly carried out if the following instructions are kept in mind.

It is well to remember that the removal of the cylinder head does not in any way affect the timing of the engine.

Timing Marks

When the engine is timed at the factory, certain marks are stamped on the gears, so that if for any reason the timing must be distrubed, then the engine can easily be reset to it's original timing.

The method of marking is as follows:- With the engine timing correctly set, the engine is turned until No. 1 piston is at T.D.C. on its compression stroke. In this position, scribed lines or center punch marks are marked on the idler gear to correspond with lines or center punch marks on the camshaft, fuel pump and crankshaft gears respectively (Ref. Fig. KI).

Fuel Injection Pump Timing Marks (VE Type Pump)

Refer section K 51 for detailed setting procedure for MICO VE type pump timing.

To Reset Engine Timing

Remove atomisers.

Bring No. 1 piston to T.D.C., No. 1 piston being on its compression stroke. The T.D.C. hat has been obtained can be checked by examining the flywheel where the T.D.C. **mark should be central within the inspection opening, or the front of the crankshaft where the key for pulley should be at the top of its periphery.**

Fit the camshaft gear on locating dowel provided on camshaft hub.

Fit the fuel pump gear. This is dowelled and will only go in one position.

(Check that the fuel pump is correctly fitted to the engine and set the spill timing as recommended in Section B)

With the crankshaft gear fitted, **replace the Idler gear** ensuring the timing marks coincide (Ref. Fig. K.1).

After testing the engine, final adjustments may be necessary to find the perfect injection point. Adjustment may be made by releasing the fuel pump securing setscrews and turning the pump in the direction required.

To Check Valve Timing

Turn the engine until maximum lift is obtained on No. 3 cylinder exhaust valve. In this position, set the clearance between rocker lever and No. 1 inlet valve to 0.048 inch (1.222 mm).

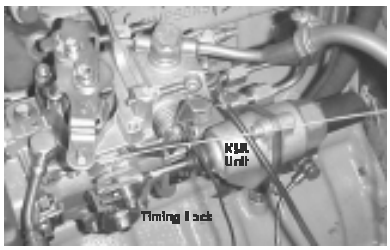
Now, turn the engine in the normal direction of rotation until the No. 1 inlet valve tip just tightens (clearance reduces to zero).

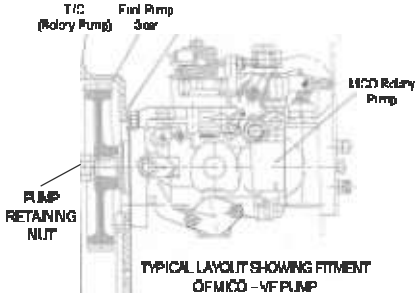
At this point, No. 1 piston should be at T.D.C. This can be checked by examining the T.D.C. provision given on the engine flywheel. A notch mark on the periphery of the crankshaft pulley has been provided and a pointer is located on the timing case cover. To set No. 1 piston to T.D.C. bring the notch mark on the pulley in line with the pointer. The ***spill timing mark*** is also provided on the periphery of the crankpulley. The tolerance for valve timing is plus or minus 2 1/2°. When the valve timing is found to be correct, adjust the valve tip clearance of No. 1 inlet valve to 0.012 inch (0.3 mm).No adjustment is provided in respect of valve timing. If the timing is found to be incorrect after the cam gear is fitted to the camshaft, then the gear may be one or more teeth out of correct mesh.

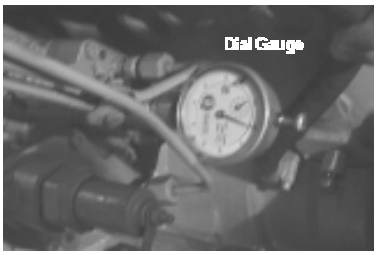
Note : *The removal of cylinder head does not in any way affect the timing of the engine.*

SUBJECT : **MICO VE Type Fuel Pump Timing Procedure (SJ 327E)**

Following description shows pump timing setting procedure applicable to SJ327E Engine fitted with MICO VE type fuel pump.







Pump Timing Setting Procedure

Recommended timing for SJ 327E engine : 0.8 mm +0 / –0.1 mm FIP plunger lift at TDC

1. Rotate Crankshaft and bring number one piston to TDC position in compression stroke (Bring No. 3 Cylinder Exhaust Valve to full open position and check timing pointer matches with TDC mark on crankshaft pulley, or established TDC mark by droping any one of the valve in number **one** cylinder)
2. VE pumps are received with Timing Lock & do not release the lock until fitment.
3. Fit the pump on the engine timing case by keeping the stud in the center of the fuel pump slot on the flange.
4. Fit the fuel pump gear on the pump shaft with the key in position.
5. Ensure the timing mark on the fuel pump gear matches with upper idler gear timing mark. (applicable during reassembly).
6. Tighten the fuel pump gear retaining nut to the torque of 92.5 ± 2.5 Nm.
7. Release the lock by unscrewing the setscrew on the fuel pump body for few threads and insert the plate comes along with fuel pump and tighten the setscrew.
8. Connect 12 Volts (DC) supply to fuel pump KSB unit in fuel pump (connect positive terminal of 12 V source to KSB terminal & negative terminal of 12V source to fuel pump body) and few minutes later KSB lever will touch the stopper in fuel pump.
9. Remove the Air vent / Bleeder screw from the fuel pump distributor head.
10. Fit the dial gauge with adapter in Air vent / Bleeder screw location in fuel pump as shown in figure.
11. Turn the engine in the anticlockwise direction until the needle in the dial gauge stops moving.
12. Turn the dial to match the needle with zero reading and lock it
13. Turn the engine in clockwise direction until first cylinder comes to TDC position (as in step no. 1).
14. Note down the fuel pump plunger lift in the dial gauge. It should be within the following specification : 0.8 mm +0 / –0.1 mm for **SJ327E engine**
15. If the value is not as per specification, loosen the fuel pump retaining (three) nuts on the timing case and swivel the fuel pump until it reaches the required specification.
16. Tighten the fuel pump retaining nuts.
17. Reconfirm the timing as per Step No. 11, 12, 13, 14 & 15.
18. Remove the dial gauge with adapter and fit back the Air vent / Bleeder screw.
19. Torque tighten the Air vent/Bleeder screw to 26 to 35 Nm.
20. Disconnect the 12 V DC source.
21. Now pump timing is completed.

KSB Terminal/Air vent screw

VE pump timing lock

KSB lever / stopper in pump

Fuel injection equipment for Simpson SJ 327 E US Tier II engine

1	**Customer**	:	Simpson & Company Ltd
2	**Application**	:	Tractor
3	**Models: -**		
4	**Engine details**		
4.1	Engine model	:	SJ 327 US Tier II
4.2	Features	:	3-cylinder, 4-stroke, water cooled, DI & NA engine
4.3	Power	:	50 HP at 2250 min
4.4	Bore x Stroke	:	95x 127 mm
4.5	Total Swept volume	:	2.7 litres
4.6	Compression ratio	:	18.3 : 1
4.7	Injection timing	:	0.8 mm lift at TDC
4.8	High pressure pipe	:	6 x 1.5 x 530 mm (OD x ID x Length)
5	**Details of fuel injection equipment**		
5.1	Pump assembly	:	0 460 423 023 -VE3/12F1125L1041
5.1.1	Connecting parts	:	Nil
5.2	**Injector**	:	F 002 C8Z 858
5.2.1	Nozzle holder	:	F 002 C80 010 - KDAL 98 P 43
5.2.2	Nozzle	:	F 002 C40 540 - DSLA 145 P 1150
5.2.3	Sealing washer	:	9 431 030 172
5.2.4	Opening pressure	:	250 - 258 bar
	(using new NH/NH spring and for resetting) Allowable drop in opening pressure drop :**up to 212 bar** (Should not be declared as defective when referred under warranty)		
5.3	**Feed pump (external)**	:	F 002 A50 021 - FP/KEG22AD111/2
5.4	**Filter**	:	F 002 H20 116
5.5	**Glow equipment**	:	Nil
5.6	**Hand primer**	:	9 440 037 000 - FP/AH 3/9
6	**Features**		
6.1	VE pump 0 460 423 023 has the following features:		
	Pump housing	:	1 465 134 758
	Drive shaft	:	1 466 100 401
	Cam plate	:	1 466 111 648
	Timing-device piston	:	1 463 104 492
	Hydraulic head	:	1 468 373 012
	Housing cover assembly	:	1 465 534 437
	Fulcrum lever	:	1 461 907 400
	Sliding sleeve	:	1 460 422 448

	Control unit	:	1 467 230 442
	Shim	:	1 460 101 620
	Fitting cover	:	1 465 530 861
	Control lever	:	1 461 933 452
	or	:	1 461 933 454
	Stop lever	:	1 461 331 359
	Spring	:	1 464 651 434
	Solenoid	:	0 330 001 042
6.2	Injector F 002 C8Z 858 consists of Nozzle holder F 002 C80 010 - KDAL 98 P 43 is a running type. Nozzle F 002 C40 540 - DSLA 145 P 1150 has the following features:		
	Number of spray holes	:	6
	Spray hole diameter	:	0.188 mm
	Needle lift	:	0.25 mm
	Characteristic group	:	2
	Identification	:	Last four digits “1150” has been inscribed on the nozzle shaft.
6.3	Filter	:	F 002 H20 116 (spin on type) is a running type.
	Please refer to the Technical information SSE-I-45/020 for further information on spin-on type filters.		
6.4	Feed pump	:	F 002 A50 021 - FP/KEG22AD111/2 is a running type
6.5	Hand primer	:	9 440 037 000 - FP/AH 3/9 is a running type
7	**Other information**		
7.1	Test specification chart	:	STS-TS-PER 2.7 a1
7.2	**Make sure that the intermediate plate is assembled to the locking screw and the drive shaft rotates freely before calibration of the pump. After overhauling/testing the pump, please set the injection timing as per the procedure and lock the drive shaft in that position by using the locking screw and ensure the intermediate plate is tied with a wire to the pump and given to the customer. Please advise the customer to remove the locking screw and use the intermediate plate after setting the injection timing on the engine.**		
7.3	**Since the ball profile of DSLA Nozzle is not hardened, extreme care to be exercised in handling the Injectors and Nozzles at all levels. Do not use emery sheet or any hard material to clean the ball profile of DSLA nozzles**		
7.4	Spare parts catalogue **:** Shall be mailed separately		
8	**Exclusive parts**		
	Pump assembly	:	0 460 423 023
	Injector	:	F 002 C8Z 858
	Nozzle	:	F 002 C40 540
	Pump housing	:	1 465 134 758
	Cam plate	:	1 466 111 648
	Hydraulic head	:	1 468 373 012

	Fulcrum lever	:	1 461 907 400
	Sliding sleeve	:	1 460 422 448
	Control unit	:	1 467 230 442
	Fitting cover	:	1 465 530 861
	Control lever	:	1 461 933 452
	Control lever	:	1 461 933 454
	Stop lever	:	1 461 331 359
	Spring	:	1 464 651 434
9	**Engine code**	:	65150 (for warranty purposes)
10	**Introduction**	:	April 2004

Applicable only for BOSCH and MICO Test benches

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Section L

LUBRICATING SYSTEM

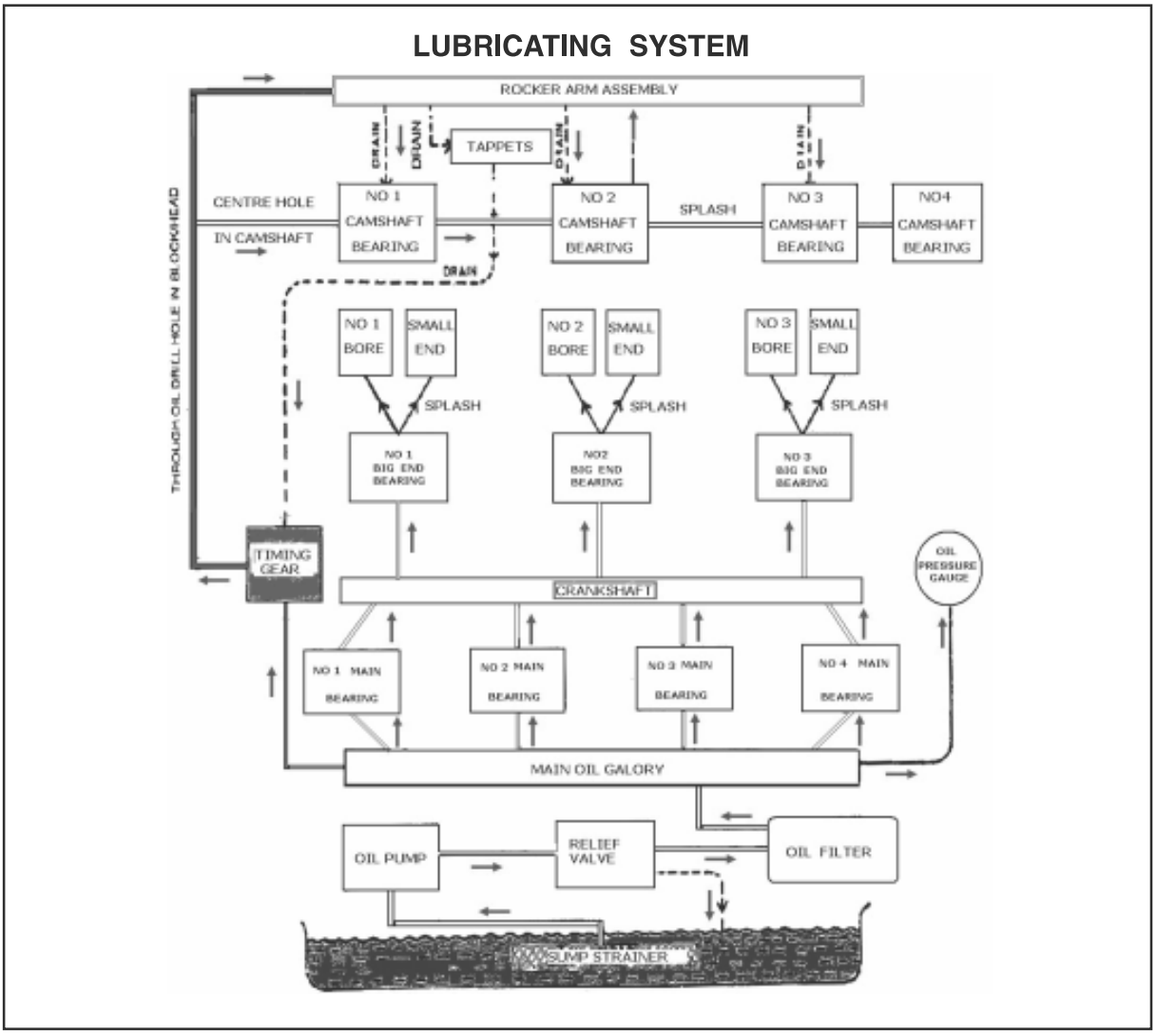


Fig. L1 – Lubrication System

The importance of correct and clean lubrication cannot be stressed too highly and all references to engine oil should be taken to mean lubricating oil which falls within the specifications given in Section Q. Care should be taken that the oil chosen is that specified for the climatic conditions under which the engine is operated.

The sump should be filled with a suitable lubricant to the correct level but do not attempt to overfill above the full mark. Before filling or checking the dipstick, ensure the application is on level ground.

Oil Circulation

The system of lubrication (Fig. L.1) comprises pressure feed to main and big end bearings, camshaft bearings, rocker shaft and timing gear train.

The pump draws oil through the strainer from the sump and delivers it by a pipe inside the crankcase through a drilling in the side of the cylinder block to the lubricating oil filter.

Oil passes through the filter and then through an internal drilling in the cylinder block to the pressure rail which is an internal passage within the crankcase.

Holes drilled in the crankcase webs feed oil from the pressure rail to the main bearings and holes in the crankshaft webs carry oil to the big end bearings. Surplus oil returns to the sump.

An oil seal prevents oil leaking along the crankshaft at the rear end and oil thrown from this seal returns to the sump.

The small end bushes are lubricated by splash and lubricating oil mist.

Running across the front of the cylinder block is an internal passage which connects with the pressure rail. The oil comes out from this passage to camshaft 1st journal and flows through the central hole running to full length of hollow camshaft. Cross drilling from this central hole delivers oil to 2nd, 3rd and 4th camshaft journals.

Oil under pressure is feed to rocker shaft through a vertical and a cross drilled passages from oil gallery.

The overflow of oil from the rocker shaft flows from the cylinder head into the camshaft tunnel and from the front of the tunnel on to the timing gears and then returns to the sump.

Lubrication of the timing gear idler hubs is by a force feed.

Lower Hub

A drilling from the front face of the cylinder block into the main bearing oil gallery, is aligned with a drilling which passes through the axle of the hub, connecting with a transverse hole in the hub, through which oil is fed to the bearing surfaces of the hub gear.

Secured to the gear retaining plate is a pipe, the other end of which is located in a blind hole in the timing case to prevent the pipe from turning. A small hole in the pipe allows oil to spray onto the teeth of the lower idler gear (The same pipe is extended for timing assembly lubrication).

Upper Hub

A transverse drilling across the front of the cylinder block from the main oil gallery feeds oil under pressure always to No. 1 journal of the hollow camshaft. This oil feed is taken from the vertical drilled passage to the rear face of the upper hub lubrication through another transverse drilling

Oil Pressure

See that oil pressure is registered on the gauge.

The actual pressure may vary with individual engines but the oil pressure at maximum engine speed and normal working temperature should be 29.86 / 59.73 psi (2.1 – 4.2 kgf/cm^2).

There will be a pressure drop while idling and a slight decrease in normal working pressure when the engine is hot.

If the oil pressure as registered on the gauge is below normal, check the following in the order given below:

1. Dipstick. Ensure the sump oil level is up to the “full” mark.
2. Oil pressure gauge. Check for accuracy with master gauge.
3. Lubricating oil filter. May be plugged.Renew element.
4. Sump strainer may be plugged. Remove, clean and replace.
5. Lubricating oil pump. Ensure that suction and delivery pipes are tight.
6. Oil pressure relief valve. Foreign matter may be preventing valve from closing.

Lubricating Oil Filters

The importance of using clean lubricating oil in the first place, and providing means to ensure that it is always clean in use, is hardly second to the importance of cleanliness in respect of the fuel.

It is imperative, therefore, that lubricating oil filters are not neglected.

To ensure cleanliness, filters are incorporated.

1. Oil Filler strainer.
2. Sump Strainer.
3. Main (full flow) filter.

The purpose of the oil filler strainer is to prevent large objects entering the sump when the engine is being filled with lubricating oil.

The sump strainer consists of a perforated container which is an integral part of the suction pipe of the oil pump.

This strainer requires no special attention, but it should be cleaned anytime the sump is removed.

Main (Full Flow) Filter

This filter incorporates a screw on canister where the element is integral with the canister. This element should be replaced not cleaned, at the appropriate time, as given in Section C.

Oil filter assembly located either in right or left side of the engine which depends upon application.

To Renew the Canister

1. Unscrew and discard old oil canister.
2. Clean the filter head and the threaded adaptor.
3. Using clean engine lubricating oil, liberally oil the top seal of the replacement canister.

4. Fill the new canister with clean lubricating oil, allowing time for the oil to filter, through the element. Screw the replacement canister on to the filter head until the seal just touches the head and then tighten by hand. Where a tool is available, tighten to 20 Nm (2.07 Kgf.m).
5. Run the engine and check for leaks. Check the oil level after running and top up as necessary.

Oil Pressure Relief Valve

The oil relief valve which is located in the oil pump body prevents the pressure becoming excessive as might otherwise happen when the oil is cold.

The relief valve comprises a spring loaded plunger.

When the predetermined pressure setting is exceeded, the valve opens and some of the oil is released,to return to the sump. This continues until the oil warms up and flows at the desired pressure. The valve then closes.

When to change the Oil

The oil in the sump must be drained in accordance with preventive maintenance and replaced by clean new oil of a specification suitable for the climate (Ref. Section Q)

To Remove Sump

Remove drain plug and drain off oil.

Remove dipstick.

Where necessary, remove setscrews securing rear of sump to flywheel housing.

Remove all setscrews securing sump to crankcase and lower sump.

To Replace sump

Remove all traces of old joints and cork strips from timing case bottom cover and rear main bearing cap.

Lightly smear crankcase faces with a thin coating of jointing compound and place joints in position ensuring all holes lined up.

When placing joints in position, it is important that the mitred ends go right up into the recesses of the timing case bottom cover and rear main bearing cap.

Lightly coat cork joints with jointing compound and place in the grooves provided in the timing case bottom cover and rear main bearing cap.

Place sump in position and screw the setscrews lightly home.

Where applicable, replace setscrews securing rear of sump to flywheel housing.

Tighten setscrews securing sump to crankcase.

Replace dipstick and sump drain plug.

To Remove Oil Pump

Remove sump (see previous heading).

Remove the bridge piece (timing case bottom half) by loosening the setscrews and nuts.

Disconnect the delivery pipe from the oil pump to cylinder block (Fig. L2).

Remove circlip and move oil pump idler gear forward.

Unscrew the three setscrews securing the oil pump to the front main bearing cap and remove oil pump.

To dismantle Oil Pump

Remove suction and delivery pipes.

Remove oil pump idler gear.

Using a special screw driver, unscrew the three screws and remove the pump end plate.

The outer rotor can then be removed.

The oil relief valve is located in the body of the lubricating oil pump. It is an adjustable valve but unless special test equipment is available, no attempt should be made to dismantle it. The relief pressure is set and adjusted before the engine leaves the works.

Inspection

The clearances for new pumps are given in Section B.

1. Thoroughly clean all parts and inspect the rotors for cracks or scores.
2. Install the driven rotor in the pump body making sure the chamfered edge of the outer rotor enters the pump body first. Check the clearance between the maximum diameter of the inner rotor and the minimum diameter of the outer rotor at all points (Fig. L4).
3. Check the clearance between the outer rotor and the pump body. (Fig. L5)
4. Check the clearance between the top of the rotors and the end of the pump body with feeler gauges and straight edge. (Fig. L 6).

Note: Should an oil pump be worn to such an extent it adversely affects the working oil pressure then a replacement pump should be obtained. The component parts of the oil pump are not supplied individually therefore

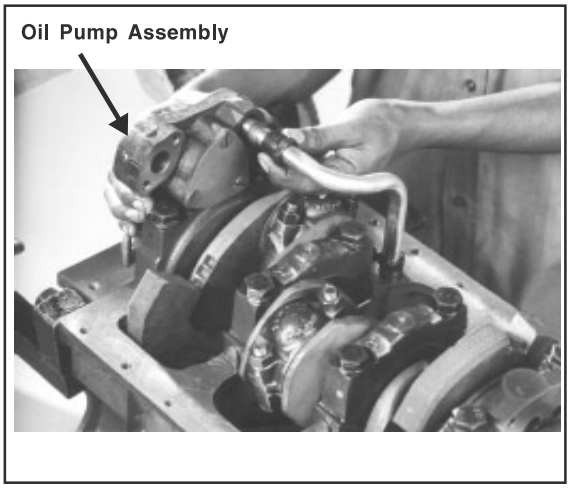


Fig. L 2 – Oil Pump / Pipe Fitting

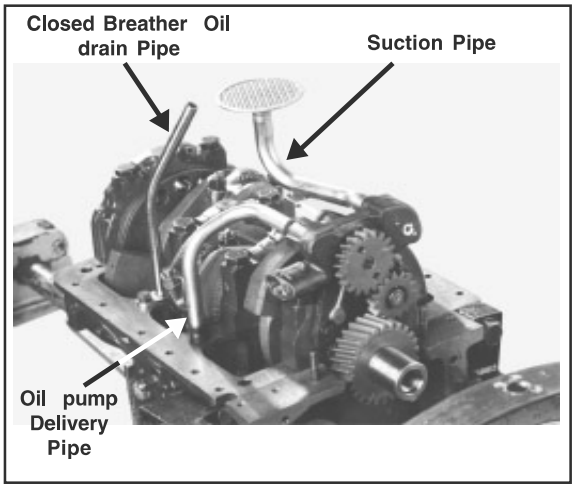


Fig. L 3 – Oil Pump / Oil Pipes

if any parts require replacing a replacement assembly should be fitted.

To Re-assemble the Oil pump

Replace outer rotor, in oil pump body. Make sure the chamfered edge of rotor towards pump body.

Replace end cover and secure with three screws.

Replace idler gear and circlip.

Prime lub oil pump with oil before fitting.

To Refit Oil Pump

Fit oil Pump to front main bearing cap and secure with three setscrews. At the same time replace suction and delivery pipes to and from oil pump.

Secure idler gear with circlip.

Replace timing case bottom half and secure with screw or nuts and washers to timing case top half.

Replace the setscrews at the bottom of the timing case front cover.

Replace sump in accordance with previous instructions.

Before starting, the engine should be turned over while operating the stop control, until oil pressure is registered.

Breathing Arrangement

The Closed Loop Breathing system ensures positive crankcase ventilation with oil separator and connecting hoses as shown in Fig. L7 / L8.

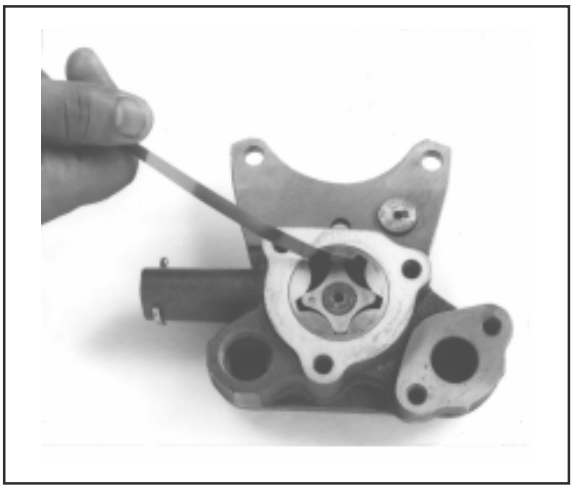


Fig. L 4 – Checking Oil Pump Clearance (Inner rotor to Outer rotor)

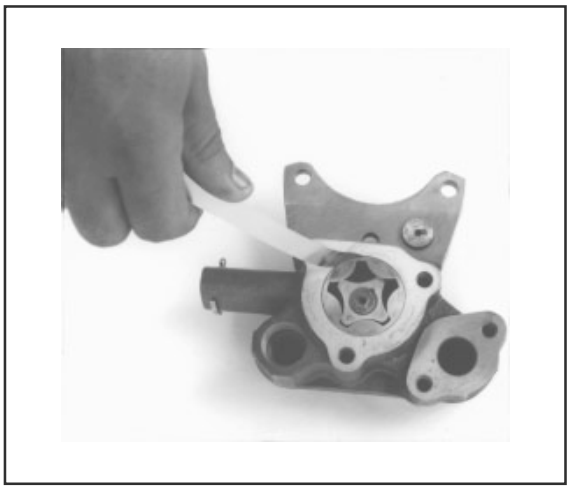


Fig. L 5 – Checking Oil Pump Clearance (Outer rotor to body)

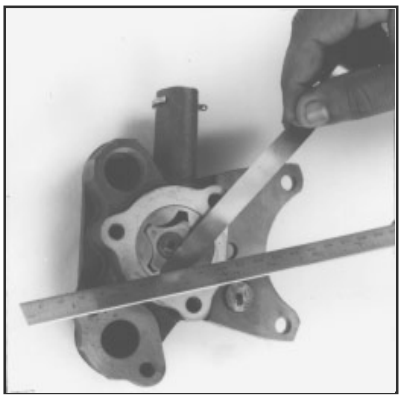


Fig. L 6 – Checking Oil pump Clearance
(Top of rotors to body)

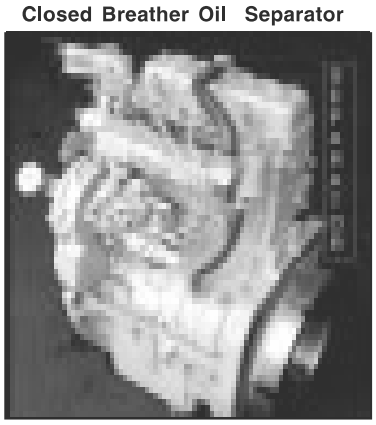


Fig. L 7 – Oil Separator Location (Sealed Unit)

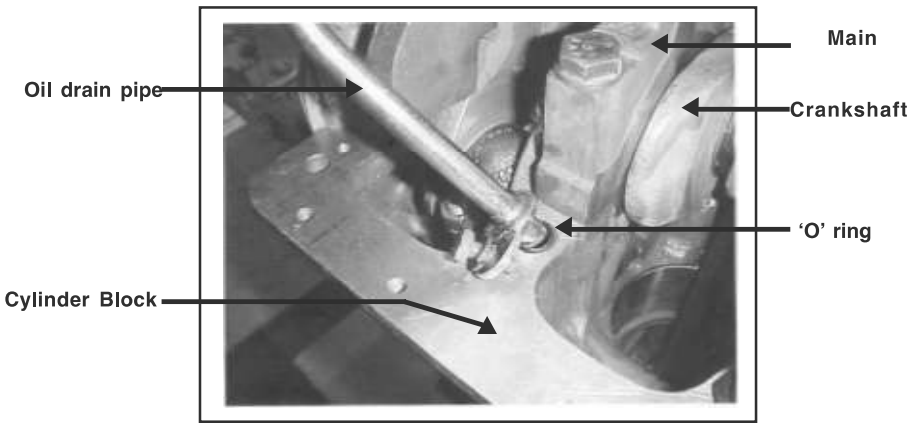


Fig. L 8 – Closed Breather Oil Drain Pipe

CAUTION

- For effective functioning of closed loop breathing system the oil filler cap and oil dipstick should not be disturbed while engine is running.
- Perfect sealing is required between oil drain pipe 'O' ring and cylinder block machined surface as shown in Fig. L 8.

Section M

COOLING SYSTEMS

COOLING SYSTEMS

The cooling water is circulated by a centrifugal type pump which is mounted on the front of the timing case cover. It is driven by a V-belt from the engine crankshaft and provision is made for fitting a fan on the front end of the water pump pulley.

The pump does not require greasing as the bearings are treated with a special quality grease before assembly.

Fan Belt Adjustment

Belt tension should be adjusted so that, without undue pressure, the belt can be depressed approximately 3/8 inch (10 mm) with the thumb applying pressure at a point midway between the water pump and alternator pulley. (Ref. Fig. M5)

Adjustment of the belt tension is achieved by altering the position of the alternator. Release the alternator adjusting link and support bracket bolts. Move the alternator to give the correct tension and then tighten the bolts and re-check the tension.

When a new belt has been fitted it is advisable to check the belt tension after a few hours running to ensure that no initial stretching has occurred.

To Remove Water Pump

Remove Fan.

Loosen alternator securing setscrews and remove fan belt.

Remove water pump inlet and outlet hose connections.

Unscrew setscrews securing the water pump and remove.

To Dismantle Water Pump

Remove the water pump pulley using a suitable tool. The tapped holes in the pulley can be utilised for this purpose (Ref. Fig. M2).

Press the water pump shaft complete with bearings and impeller from the rear of the pump body. Press the shaft and bearing assembly out of the impeller.

Remove the unitised seal from the shaft.

The shaft and bearings are manufactured as one component and cannot be dismantled.

To Re-assemble Water Pump

With the shorter end foremost, press the shaft and bearing assembly into the rear of the water pump body until the bearing housing end is flush with the front of the water pump body.

Fit the unitised seal.

Supporting the shaft at the front end, press the impeller with blades inwards onto the rear of the shaft until a dimension of 0.0098 / 0.02 inch (0.25 mm to 0.51 mm) is obtained between the blades of the impeller and the pump body (Ref Fig. M3/M4).

Spin the assembly to ensure freedom of rotation. Replace the four setscrews (used instead of studs and nuts used for securing the water pump on to the timing case cover.

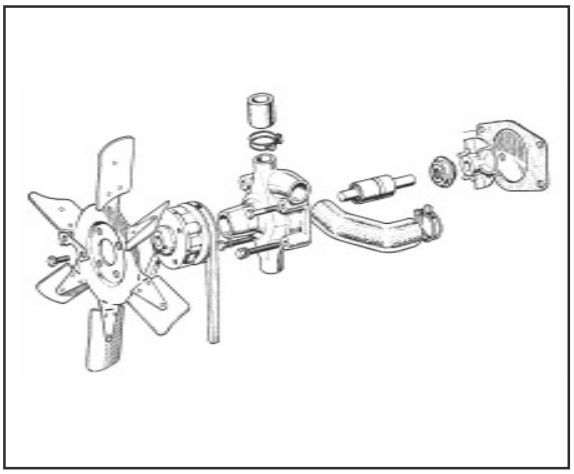


Fig. M 1 – Water Pump Exploded View

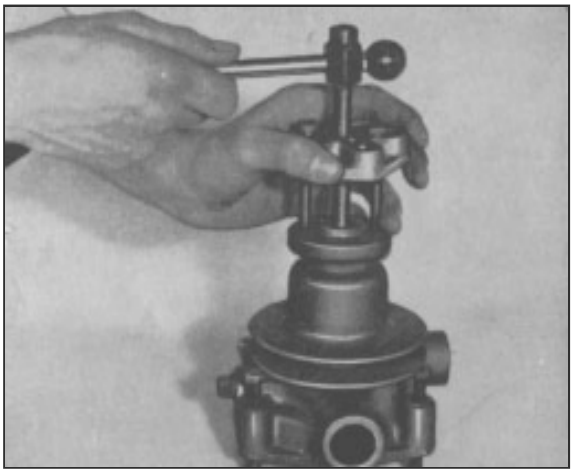


Fig. M 2 – Water Pump Pulley Removal

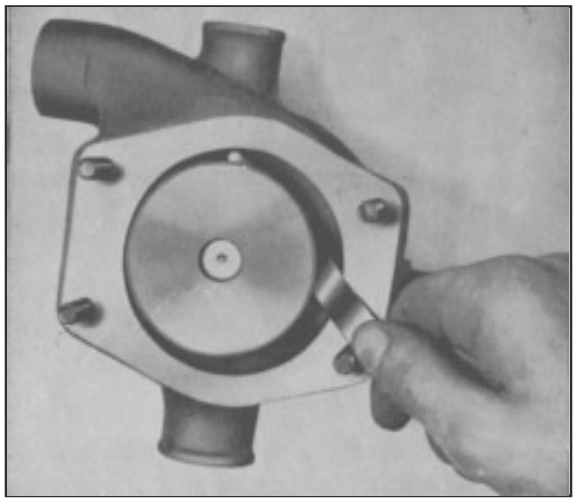


Fig. M 3 – Checking Impeller Clearance

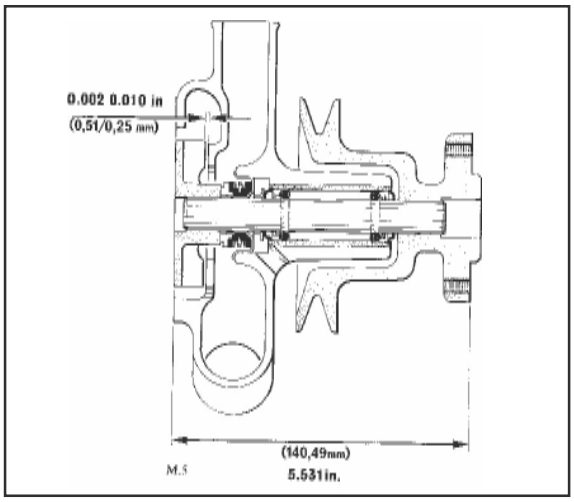


Fig. M 4 – Water Pump Cut Section

Supporting the shaft at the impeller end, press on the water pump pulley until the front end of the fan mounting face is 5.5311 inch (140.49 mm) from the rear face of the pump body (Ref. Fig. M4).

Recheck the clearance between the impeller blades and pump body, and spin the assembly to ensure freedom of movement.

To Re-fit Water Pump to Engine

Fit new water pump joint, using jointing compound.

Connect up water pump inlet and outlet hose connections.

Replace fan belt and tension.

Replace fan.

Thermostat

A thermostat is fitted in the cylinder head water outlet to assist in providing a shorter warming up period for the engine. The thermostat can be removed after the water outlet connection and joint have been removed. When refitting the thermostat, ensure that the jiggle pin (if provided) in the top of the thermostat is free to move in its location.

To check the thermostat, suspend it in water and heat gradually. With a thermometer, check that the thermostat operates at the temperatures given in Section B. If it is faulty, it should be replaced no attempt should be made to adjust a faulty thermostat.

Note : *Blanking sleeve should be provided to close the by-pass if the thermostat is not fitted.*

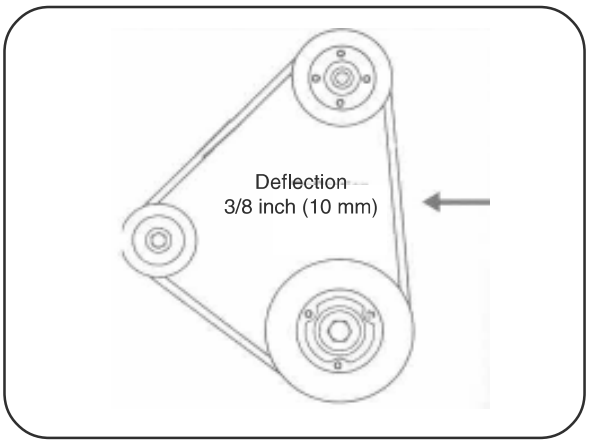


Fig. M 5 Checking Belt Tension

Section N

FUEL SYSTEM AND AIR CLEANERS

FUEL SYSTEM AND AIR CLEANER

The principal components of the equipment for delivering the fuel oil to the engine are as follows:

Filters

Fuel Lift Pump

Fuel Injection Pump

Atomisers

So accurate is the manufacture of the fuel injection equipment that the importance of cleanliness when handling fuel cannot be over stressed.

Adequate filters are provided in the system, but much can be done by the operator to ensure that the equipment is maintained in first class condition.

All fuel used must conform to :-

BRITISH STANDARD No. BS. 2869: 1970 CLASS A or I.S: 1460/2000 Grade special or Grade A and must be clean, free from water, suspended dirt and other foreign matter. Filtering of fuel before it enters the tank will help, and regular filter changing will ensure that only perfectly clean fuel reaches the fuel injection pump.

Given these conditions, ninety per cent, at least of potential engine troubles would be eliminated. Attention is on that account earnestly directed towards the section of this manual which refers to the care and upkeep of filtering apparatus.

In a pressure fed system, the lift pump lifts the fuel from the tank via the pre-filter (if fitted) and then passes it through the dual filter to the fuel injection pump, which delivers it in measured quantities and at appropriate intervals, to the atomisers.

Where no lift pump is fitted, i. e. in a gravity fed fuel system, fuel flows from the tank, through a pre-filter,to the dual filter. From there, filtered fuel enters the injection pump which delivers it to the atomisers.

The Fuel Lift Pump

The lift pump is of the plunger type and is driven by engine camshaft on the exhaust manifold side.

A hand primer is fitted for use if the supply of fuel from the tank has at any time failed, and for bleeding.

The fuel pump is an instrument of precision. Its working parts are made to extremely fine limits and mishandling in any shape or form, or the entry of the smallest particle of dirt into its working parts may damage it and diminish its accuracy of operation. Hence the importance of ensuring that the fuel is thoroughly filtered before it reaches the pump.

When requesting information regarding the fuel pump, the type and number should be quoted. This can be obtained from a plate fitted on the pump.

Fuel Pipes

No two of the pressure pipes from the fuel pump to the atomisers are alike. Keep this in mind when replacing.

Examine the nipples which will be found on each end of these pipes.

If the union nuts at any time have been over-tightened, the nipples may have been damaged. If so, leakage will result and the complete fuel pipe will have to be replaced.

In this connection, bear in mind that the working pressure which these joints must sustain is several thousand pounds per square inch. Only a perfect joint is satisfactory.

Assemble the pipe to the fuel pump and atomiser unions to check that the pipe fits square at both ends. Do not fit one end and then bend the pipe to square it with the other union.

When fitting the pipe, tighten the unions alternately a little at a time, first one end and then the other.

If the pipe is square to the unions at each end as described above, no force will be needed to make a good joint. No force should be used.

Use only a standard open ended spanner.

If the union is tightened excessively, the nipple may be damaged. The same danger exists if the pipe is not square to and central with the union.

When changing an atomiser, always remove the pipe entirely. Never undo only one end leaving the other tight. Never bend the pipe.

Atomisers

Each atomiser consists of a steel body, tightened to the cylinder head by means of a union nut. (Ref. Fig. E5 / E6,).

The joint between the atomiser and cylinder head is made by a special copper washer between the lower face

of the nozzle cap nut and the recess in the cylinder head.

When preparing to fit the atomiser in its place in the cylinder head, care should be taken that only special type of copper washer is used to make this joint. The recess in the cylinder head, the faces of the copper washer and the corresponding face on the nozzle holder cap nut should be perfectly clean if a leakproof joint is to result.

It is advisable to fit a new joint washer when the atomiser is replaced, after having been removed for any reason.

Ensure that the old washer has been removed from the cylinder head or atomiser.

This joint washer should be an easy, but not loose fit for the atomiser nozzle and it is because this is such an important feature that only washers specially made for this purpose should be used and none other. On no account should ordinary spark plug type washers be used.

The atomiser can now be fitted in place, care being taken to see that it is an easy fit in the cylinder head union nuts, so that it can be placed down on the copper joint without force of any kind. The union nut should then be tightened down evenly in order to prevent the atomiser nozzle from binding and being damaged in the cylinder head. This is very important since any insufficient in tightening down may cause distortion of the atomiser nozzle resulting in its failure and will most certainly result in blowby.

Maintenance

Atomisers should be taken out for examination at regular intervals. How long this interval should be is difficult to advise, because of the different conditions underwhich engines operate.

When combustion conditions in the engine are good and the fuel tank and filtering system are maintained in first class order, it is often sufficient if the atomisers are tested at lengthy intervals. For details refer to Maintenance Section C.

It is no use taking atomisers out for attention unless an atomiser testing pump is available or spare atomisers are at hand for substitution.

Good connections along with adequate cooling and clean diesel fuel will ensure less maintenance of the atomisers and longer efficient service life. In this connection, since there is no other item upon which the performance of the engine depends so much, it pays the user to see that the engine never runs with any of its atomisers out of order.

Troubles in Service

The first symptoms of atomiser trouble usually fall under one or more of the following headings:

1. Misfiring.
2. Knocking in one (or more) cylinders.
3. Engine overheating.
4. Loss of power.
5. Smoky exhaust (black).
6. Increased fuel consumption.

Often the particular atomiser or atomisers causing trouble may be determined by releasing the pipe union nut on each atomiser in turn, with the engine running at approximately 1200 RPM. This will prevent fuel being pumped through the nozzle to the engine cylinder, thereby altering the engine revolutions. If after loosening a pipe union nut, the engine revolutions remain constant, this denotes a faulty atomiser.

After stopping the engine the nuts from the flange of the doubtful atomiser should be removed and the complete unit withdrawn from the cylinder head and test using a atomiser / nozzle tester and / or have tested by a authorised fuel pump station.

Atomiser Pressures

No attempt should be made to service or reset, the pressure of an atomiser unless the proper equipment is available. (Ref. Section B,)

When renewing atomisers, reference should be made to the appropriate Parts list to ensure fitment of the correct type.

Air Cleaners

The time period for cleaning the air cleaner depends on operating conditions. Therefore under extremely dusty conditions, the time limit recommended for cleaning or replacement period should be decreased.

The correct maintenance of the cleaner will greatly assist in extending the life of the engine.

Dry type air cleaner / Maintenance

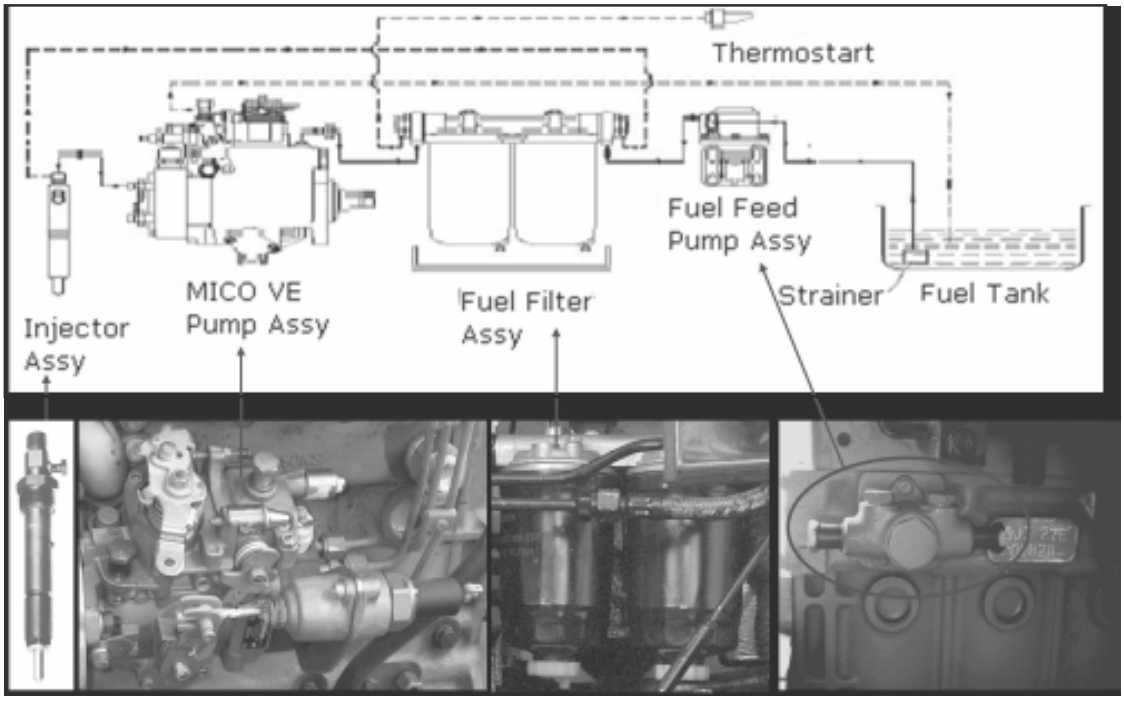
The dry type air cleaner is provided with paper elements. The elements are not to be removed or cleaned or tapped but should be replaced whenever the element is found plugged which would be identified by restriction indicator or by loss of power or speed drop or emission of black smoke from the exhaust.

A dust collecting bowl or ejector valve is provided at one end of air cleaner. The dust collected in the bowl must be emptied at the end of each day's operation initially. Depending upon the field conditions and the amount of dust collected, the frequency of emptying the above bowl can be altered. (For Details Ref. Section C,)

It should be ensured that the hose connections, metal pipe connections and their clips between the air cleaner outlet and the inlet of air inlet manifold of the engine are secured and are airtight.

Care should be taken to see that no unfiltered air enters the system through these connections.

For specific type of airfilter contact concerned OEM for more details.



DO NOT CLEAN FUEL FILTERS

MICO Fuel Filter Maintenance

0.5 Litre Dual Filters

Replace first stage filter insert after every 500 hrs.

Replace second stage filter insert after every 750 hrs.

Fig. N 1 – Typical Fuel Pipe Layout

Procedure for Eliminating Air from Fuel system (SJ327E with VE type Fuel Pump)

Following procedure describes eliminating air from the fuel line system in SJ 327 E engine fitted with MICO VE type fuel injection pump applicable to tractors

1. Ensure diesel flows freely at feed pump inlet and tighten the banjo bolt.
2. Operate hand primer
   - Release air at vent screw from primary bowl of fuel filter. Ensure fuel flows without air and tighten the vent screw.
   - Release air at vent screw from secondary bowl of fuel filter. Ensure fuel flows without air and tighten the vent screw
   - Release air at over flow banjo bolt (marked OUT on banjo bolt top) of fuel injection pump. Ensure fuel flows without air and tighten the overflow banjo bolt.
3. Then loosen the three nuts of high pressure fuel pipe at atomiser.
   - Crank the engine with the help of battery until fuel flows free of air.
4. Tighten the three nuts of high pressure pipe at atomiser.
5. Engine is now ready to start.

Section P

FLYWHEEL AND FLYWHEEL HOUSING

FLYWHEEL AND FLYWHEEL HOUSING

Alignment of the Flywheel Housing and Flywheel

It is most important that the flywheel housing be correctly aligned with the crankshaft. Misalignment may give rise to difficulty in changing gear, etc. If the housing has been removed, as is necessary for a complete overhaul, the greatest care must be taken on replacement to ensure accuracy of alignment. The appropriate procedure is as follows:-

See that the face of both the rear of the cylinder block and flywheel housing are perfectly clean and free from burrs.

Set the housing on to the studs and tighten, but not overtight so as to allow adjustment.

Alignment of the Flywheel Housing Bore

Secure the base of a “dial” gauge to the flange of the crankshaft.

Set the needle of the gauge to the inside of the bored hole in the flywheel housing.

Turn the crankshaft and check that this is truly central. The housing is adjusted until it is central.

For convenience in turning the engine it is advisable to release (but not remove) the nut holding the atomisers in place.

The flywheel housing bore should be truly central with the crankshaft within the limits given in the table (total indicator reading).

Alignment of the Flywheel Housing Face

With the face of the “dial gauge” still bolted to the crankshaft flange, adjust the “dial” so as to set the needle against the vertical machined face of the flywheel housing, and, again turning the crankshaft, check that this face is perpendicular to the crankshaft axis. When carrying out this check, the crankshaft should be pressed forward to take up end float.

This facing should be within the limits given in the table (total indicator reading) of being truly at right angles to the crankshaft axis.

All adjustments to bring the flywheel housing within the limits must be on the flywheel housing and under NO CONDITIONS must the rear of the cylinder block be interfered with.

When the housing is properly aligned to the above limits, tighten the securing nuts evenly.

Ream the dowel holes and fit the correct length and size dowels.

Fitting Flywheel and Checking Alignment

With the flywheel and crankshaft flange perfectly clean and free from burrs and with two suitable guide studs fitted in the crankshaft flange, position the flywheel on the crankshaft.

Insert the setscrews complete with locking plates into the flywheel holes and tighten evenly.

Secure the base of the “dial” gauge to the flywheel housing. With the flywheel at top center, set the needle of the gauge on the periphery.

Turn the crankshaft and check the dial, the flywheel should run truly within 0.011 inch (0.30 mm) (total indicator reading).

With the base of the ‘dial” gauge still bolted to the flywheel housing, adjust the dial so as to set the needle against the vertical machined face of the flywheel.

Again turn the crankshaft and check the dial. The flywheel should be truly at right angles to the crankshaft axis within the limit of 0.001 inch (0.025 mm) per 0.9842 inch (25 mm) of flywheel radius from the crankshaft axis to the dial gauge plunger (total indicator reading).

When the flywheel has been checked for correct alignment, lock setscrews with locking plates.Finally grease the spigot ball race if fitted.

LIMITS FOR FLYWHEEL /HOUSING ALIGNMENT

Housing Dia			
Upto 14.25 inch (362 mm)	....	...	0.0059 inch (0.15 mm)
Over 14.25 inch (362 mm) to 20.11 inch (511 mm)	....	...	0.0078 inch (0.20 mm)
Over 20.11 inch (511 mm) to 25.51 inch (648 mm)	....	...	0.0098 inch (0.25 mm)
Over 25.51 inch (648 mm) to 31.06 inch (789 mm)	....	...	0.011 inch (0.30 mm)

Section Q

LUBRICATING OIL SPECIFICATION

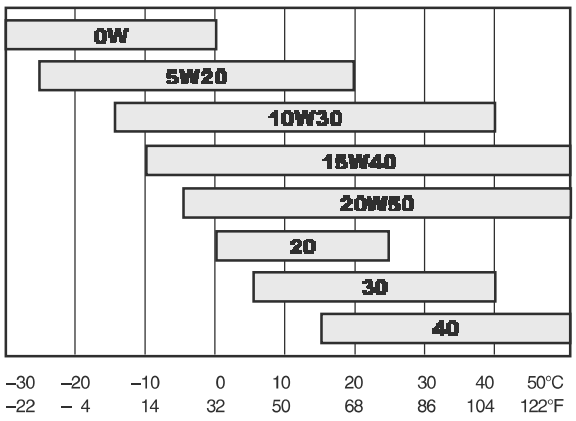
LUBRICATING OIL SPECIFICATION

Use only a good quality lubricating oil to the relevant specification as shown in the table below.

Attention : The type of lubricating oil to be used may be affected by the quality of the fuel which is available.

Always ensure that the correct viscosity grade of lubricating oil is used for the ambient temperature range in which the engine will run as shown in the chart below.

Recommended SAE viscosity grades



FUEL SPECIFICATION

To get the correct power and performance from your engine, use good quality fuel. The recommended fuel specification for Simpsons engines is indicated below :

Cetane number	:	45 minimum
Sulphur	:	0.2% of mass, maximum
Viscosity	:	2.5/4.5 centistokes at 104°F (40°C)
Distillation	:	86% at 662°F (350°C)
Density	:	0,835 / 0,855 kg/litre

Cetane Number : Indicates ignition performance. A fuel with a low cetane number can cause cold start problems and affect combustion.

Viscosity : Is the resistance to flow and engine performance can be affected if it is outside the limits.

Density : A lower density reduces engine power, a higher density increases engine power and exhaust smoke.

Sulphur : A high sulphur content can cuase engine wear. Where only high sulphur fuels are available, it is necessary to use a highly alkaline lubricating oil in the engine or to renew the lubricating oil more frequently.

Distillation : This is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light-weight hydrocarbons can affect the combusion characteristics.

Low temperature fuels

Special winter fuels may be available for engine operation at temperatures below 32°F (0°C). These fuels have a lower viscosity and also limit the wax formation in the fuel at low temperatures. If was formation occurs, this could stop the fuel flow through the filter.

APPENDIX I

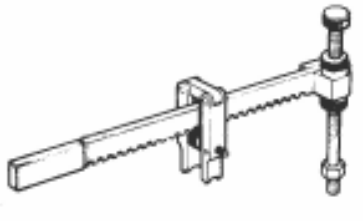
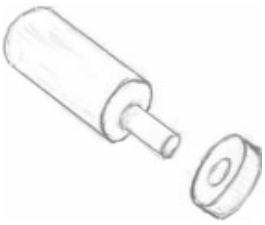
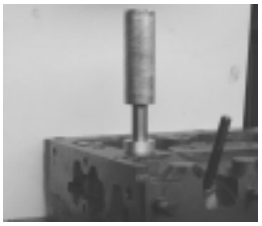
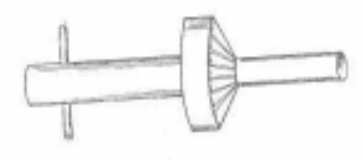
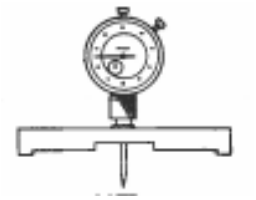
ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATUION
	Cylinder head valve spring compressor with adaptor	SER 285
	Valve guide remover and replacer (Make use of screw or arbor press)	 SER 286
	Valve stem seal replacer	SER 287
	Valve seat cutter	SER 294
	Piston height and valve depth gauge	SER 349
Replacer Remover	Cylinder liner remover/replacer adaptors suitable for liners of 3.75 inch dia. (Make use of hydraulic press)	SER 350

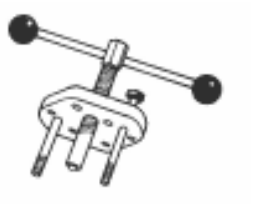
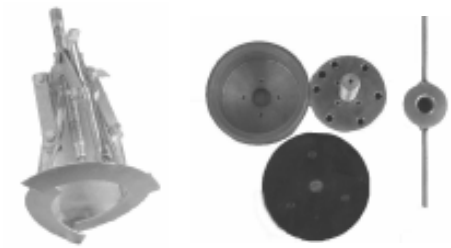
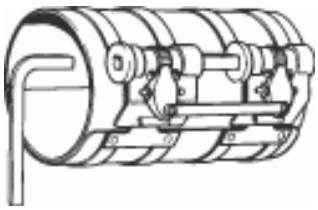
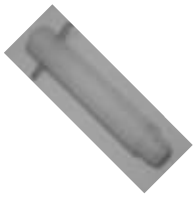
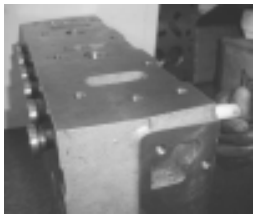
ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATION
	Timing cover centraliser	SER 290
	Timing cover oil seal replacer	SER 291
	Basic puller	SER 344
	Crankshaft rear end oil seal replacer (Cassette type oil seal)	SER 342
	Piston ring compressor	SER 348
	Oil filter remover	SER 347

ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATION
	Used for checking pump timing : (Applicable for In-line pump) Fuel pump spill pipe supplied with gravity tank, connecting banjo and pipe (Used for checking spill timing)	 SER 289
	Adapter to check timing using dial gauge	 SER 345
	Compressor tester	 SER 285
	Angle gauge	 SER 292
	Tappet holding stick	 SER 293
	Atomiser fuel injector remover and replacer.	 SER 346